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THE FIRST YEAR'S PREPARATORY WORK ON THE PANAMA CANAL

By John F. Wallace.

Mr. Wallace's first article, which appeared in our issue for September last, outlined broadly the Canal problem and the mode in which it must be attacked. His second paper, last month, stated concisely the conditions existing on the Isthmus when the Canal Commission took over the property, and described the preliminary work of organization, water supply, sanitation, and other preparations essential to the main attack. Reference to these articles will give the reader a fuller understanding of the one following.

In this, the third of the series, the author presents a most interesting summary of the actual construction work accomplished during the year he remained in charge—the total output, the unit costs under varying conditions, and the bearing which the results have upon the final solution of the question "What type of canal shall we build?" More impressive still is the revelation he makes of the strangling effect of Governmental methods upon constructive enterprise. His arraignment of the "moss-covered traditions of Governmental control"—his revelation of "the so-called free hand, with the rest of the body and limbs tightly bound with red-tape"—his appeal for the application of "ordinary and common-sense methods to the accomplishment of the work"—these will be at once recognized as throwing the much-needed light on the only real difficulties in the execution of the great project. They are a dignified statement of facts for which the world has been waiting. A fuller interpretation of their meaning will be found in our editorial on page 252.—THE EDITORS.

THE Panama isthmus was evidently formed by the same upheaval that created the mountain ranges in the two American continents. The minimum disturbance and upheaval, however, occurred at the Isthmus of Panama. There the elevation of the original pass through Culebra was approximately 300 feet above the sea-level. This pass, however, was so narrow that the slopes of the summit excavation have obliterated it; these slopes extending and cutting into the higher ground on the sides have made the excavation apparently much deeper.

The axis of the Isthmus extends in a general easterly and westerly direction, although trending slightly to the northeast and southwest in the general vicinity of the canal location at Panama.

Winding through the hills and coming down from a northeasterly direction parallel to the summit range to the southeastward, flows the Chagres, until it reaches Gamboa in the vicinity of Obispo, flanked to the northward by a secondary range in which, however, there is a decided break in the vicinity of Bohio. Below Gamboa the Chagres takes an abrupt turn of over 90 degrees, and flowing to the northward, enters the Caribbean sea west of Colon and Limon bay.

A careful study of the geology of the Isthmus has convinced me that at one time a narrow estuary of the sea extended as far inland as Obispo, and that the original mouth of the Chagres river was practically at the head of this estuary, above which point the Chagres possesses all the characteristics of a mountain stream. In the dry seasons it is a limpid stream—a succession of deep pools of water clear as crystal, connected here and there with rapids where the river swiftly flows over gravel bars and through boulders.

While the hills below Gamboa on each side of the river between Obispo and Bohio approach to within a few thousand feet of each other, still the slope of the river is flat as compared with that above Gamboa. Below Bohio the valley gradually widens, and from Gatun the river courses through marsh lands to the sea.

Thorough investigations were made in the vicinity of Colon, which showed that there was no true rock in the harbor above the elevation of fifty feet below the sea-level. The harbor itself is filled with soft material to a great depth, except the coral reef upon which the outer edge of Colon is located, extending up to and slightly beyond the mouth of the canal as located by the French engineers in the vicinity of Cristobal Colon. This coral ledge is only nine to twelve feet in thickness and underlaid by clays and alluvial deposits.

At several points along the line of the canal, various seeming rock formations were encountered, but all were of a sedimentary nature—generally clay formations which could be easily cut with a *machete* —never more than hard compact clays of very fine grain. Above the surface of the water in some places, it had the appearance of wave-washed rock. In some localities a rock of the pudding-stone type or a conglomerate was found, composed of gravel and boulders cemented together; but what was ordinarily known as "bed-rock" was not found to exist near the surface at any point along the Chagres valley between Obispo and Colon.

As the topography of the country was not suitable for dam sites between Gatun and Colon, it was not necessary to take borings for a distance of more than 50 feet below the level of the sea; 40 feet below the sea-level would be the maximum depth of excavation. As a possibility for a dam site had been suggested in the vicinity of Gatun, thorough diamond-drill borings were made in this locality, the result of which showed that no continuous bed-rock existed above the elevation of 200 feet below the sea-level. This does not mean, however, that the lowest point of the bed-rock in this vicinity existed at 200 feet below the sea-level, or that it did not exist at much greater depths at other than those points where borings were taken; but as 200 feet was considered in excess of the practicable depth at which it was advisable to construct a foundation for a dam, it was not considered necessary to go deeper.

Owing to the fact that the report of the first Walker commission was based upon the construction of a dam at Bohio, extraordinary care was taken in the investigation made at that point; not only were the borings taken with a diamond drill, but when what was supposed to be bed-rock was encountered, cores were taken from the rock in some cases to the depth of 25 or 30 feet, in order to determine the nature of the material and the fact that it was the bed-rock beyond doubt. Borings were also taken at intervals as close as 50 feet apart on various lines, in order that the maximum depth of the original geological gorge might be thoroughly ascertained. At this place the lowest point of bed-rock was definitely determined at approximately 167 feet.

The original gorge was found to be filled with a heterogeneous mass of material. While immediately next to the bed-rock there existed a shallow stratification of clay, above was a loose porous deposit of boulders and coarse gravel, interspersed with masses of drift wood and the various forms of detritus usually brought down into an alluvial valley by a mountain stream. The careful tests made showed the material to be freely water-bearing, and more so as the bed-rock was approached—the water being fresh even at the maximum depths.

All of the favorable points in the valley between Bohio and San Pablo were carefully explored, and while the bed-rock showed a tendency to rise further up the river, it was not found at such depths as to warrant the selection of a dam site which would be any more favorable than that at Bohio, considering all of the circumstances connected with the situation.

The borings taken at Gamboa, however, across the valley of the Chagres to the eastward of Obispo, showed the bed-rock to be at sea-level, and the conformation of the topography above the surface at this point, together with the higher elevation of the bed-rock, rendered it an ideal situation for the location of a dam.

The general result of the surveys and examinations between Obispo and Colon tended to the conclusion that bed-rock existed at some unknown depth greater than 200 feet at Gatun, and at depths varying from 167 to 150 feet between Bohio and Buena Vista, gradually rising towards the latter point; and also that the sea evidently originally occupied this valley as far as Obispo, which point at some time was the mouth of the Chagres river. During the ages that have since elapsed, the heavy rains of the tropics feeding the Chagres, and the floods of the river, have been gradually filling up this estuary with the debris washed down from the highlands. Boulders, gravel, and heavier sands were first deposited in the upper part of the original gorge, until it had been partly filled and a new slope established for the water, allowing such a slackening of the current as to permit of a deposit of clays, interspersed with beds of gravel and sand, dependent upon the height and nature of the various floods that occurred. When these waters spread out, however, on the flatter slopes of the lower Chagres, and the current became absolutely deadened by its contact with the sea, the finer clays were deposited.

It is also probable that a gradual subsidence has occurred, and that part of the Chagres valley, which is now below sea-level, was at one time at a higher elevation.

It is not necessary for the purpose of this paper to describe in detail the laborious work necessary on the part of the engineers to acquire the information developing these facts.*

The technical studies of the engineers also determined the unadvisability of the construction of the suggested "Tiger Hill Cut-off."

Mr. Ehle's surveys of the upper Chagres valley developed the possibility of securing a much larger flood lake area by the construction of the Gamboa dam, than was indicated by the original topographical maps, and his investigations also determined the length and possibilities of a tunnel route for diverting the surplus water of the

*Attention is called, however, to the fact that while various complaints have been made by persons occupying clerical and other positions in Panama and Colon, no complaints were made by the civil engineers, who, in fact, were the only ones that encountered and endured what might be called real hardships and privations. Much credit is due to the various engineers and their staffs mentioned in a preceding article, who conducted these technical investigations and studies.

Chagres, contained behind the Gamboa dam, into the head waters of the Juan Diaz on the Pacific slope; and further, an alternate plan for the diversion of these waters on the Caribbean slope.

On the latter, which was a shorter and less expensive line, a plan of an open cut was evolved, and also such data of a hydraulic nature were obtained as would enable a proper determination to be made of the control of the Chagres river through the construction of the Gamboa dam and works of an incidental nature. Briefly, Mr. Ehle determined the following facts: —

The practicability of the construction of a dam at Gamboa, which, constructed at certain elevations, would give surface areas as shown below: —

200	feet	above	sea-level,	a	lake	area	of	approximately	43	sq.	miles
170	"	"	"	"	"	"	"	"	31	"	"
132	"	"	"	"	"	"	"	"	15	"	"

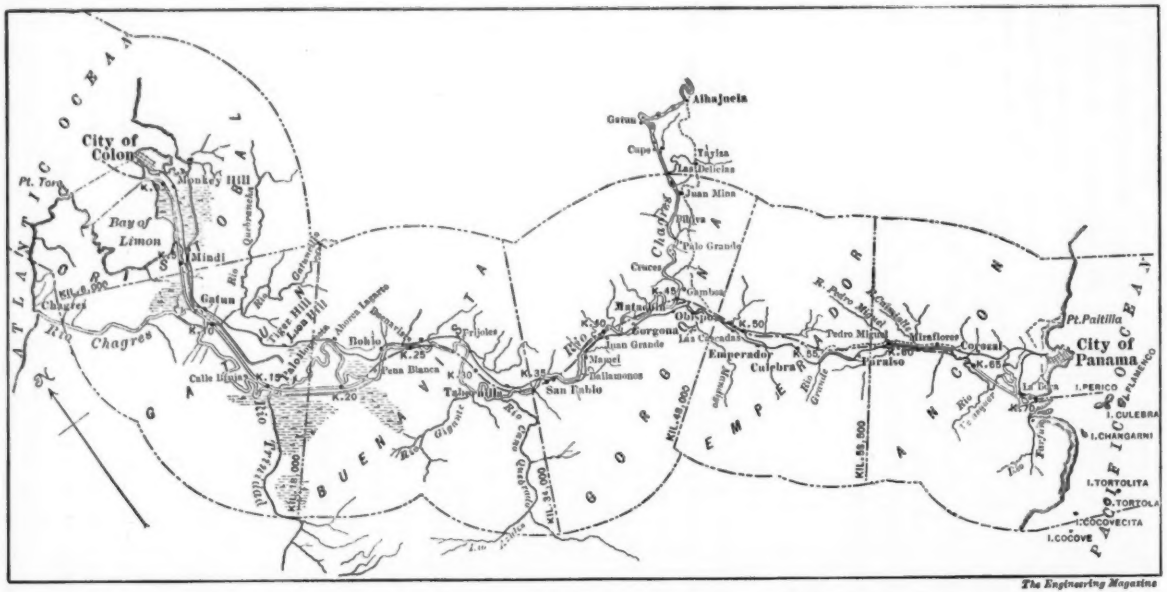
These areas were determined by the estimates based on actual surveys, the bed of the Chagres river being at approximately 50 feet above the sea-level at Gamboa.

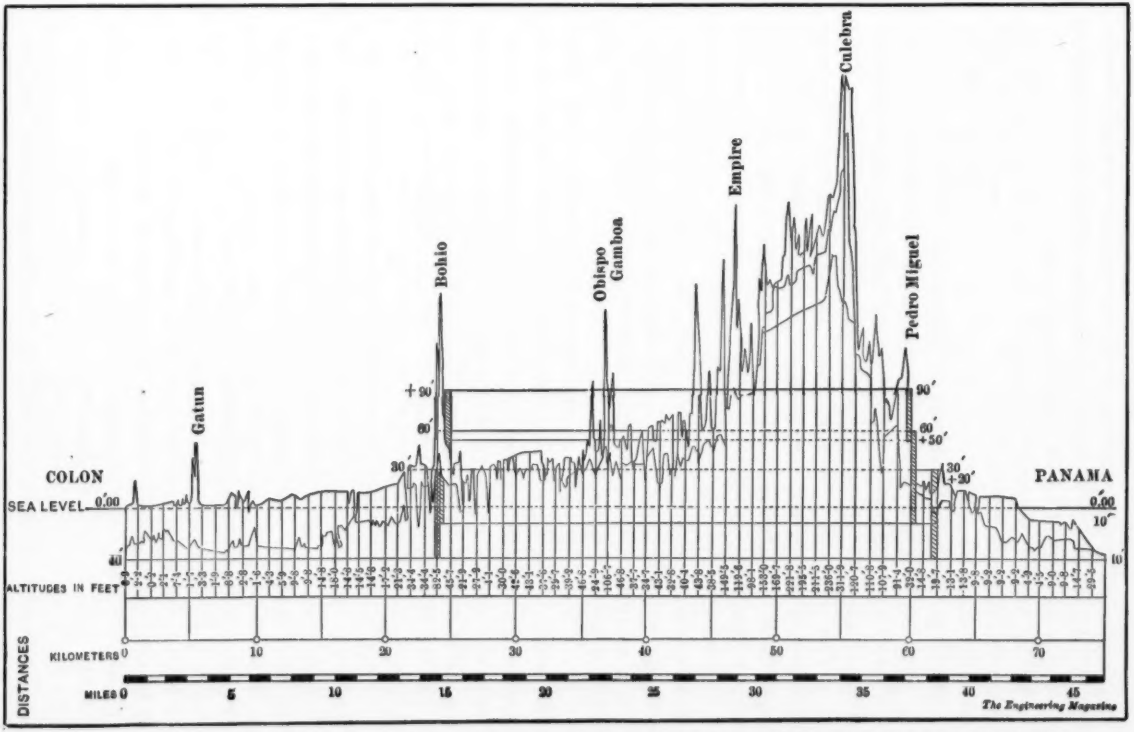
The 200-foot contour line was determined by actually running a line at that elevation, around the sides of the valley.

Without going into details of the hydraulic problem, it is sufficient to state that the results of investigations determined the practicability of a dam at Gamboa, creating a lake of sufficient dimensions to control the flood waters of the Chagres river; and also gave the data for determining the question of the control of the average flood of the Chagres, as regulated by the lake created by the construction of this dam, and indicated several methods by which this result could be accomplished; the estimated cost thereof being contained in the official reports, with full details.

From the data obtained, I can see no reason why it would not be practicable to permit the waters of the Chagres river, as controlled by the Gamboa dam project, to enter and follow the regular canal prism, which would give two outlets to the sea, one in each direction; as the average discharge of the Chagres river through the entire year could be easily taken care of in the canal prism without materially interfering with either the maintenance or operation of the canal, although it might be well to prepare for taking care of a portion of this water through a parallel conduit, which would also intercept the drainage of the hills on the east side of the canal, and act as a diversion channel.

Especial attention is called to the Gamboa dam location for the


ATLANTIC OCEAN
City of Colon
Pt. Toro
Monkey Hill
Bay of Limon
Mindi
Gatun
Chagres
Rio Chagres
Calle Iturbe
Buena Vista
Bohio
Pena Blanca
Frijoles
Tabernilla
San Pablo
Gorgona
Juan Grande
Manuel
Indianos
Matachin
Obispo
Cruces
Gamboa
Palo Grande
Juan Mina
Tavisa
Las Delicias
Cupe
Alhajuela
Chagres
Las Cascadas
Emperador
Culebra
Pedro Miguel
Miraflores
Corozal
Paraiso
Pt. Paitilla
City of Panama
La Boca
I. PERICO
I. CULEBRA
I. CHANGARINI
I. TORTOLITA
I. TORTOLA
I. COCOVECITA
I. COCOVE
PACIFIC OCEAN
Rio Grande
Rio Farfan
Rio Paraiso
Rio Pedro Miguel
Rio Obispo
Rio Gigante
Rio Caño Quebrado
Rio Gatuncillo
Rio Quebrada Ancha
Rio Trinidad
Rio Gatun
Rio Boqueron
Rio Caño Quebrado
Rio Frijoles
Rio Gamboa
Rio Chagres
Rio Trinidad
Rio Farfan
Rio Paraiso
Rio Grande



PROFILE OF THE PANAMA CANAL, SHOWING ORIGINAL SURFACE OF THE GROUND AND THE EXCAVATION DONE BY THE FRENCH.
The reader is referred to the explanatory note under the map on page 166.

reason that it is a necessary adjunct to any plan of a canal which may be decided upon at sea-level, or the summit-level of which may be at any height not exceeding 60 feet, and in which an intermediate navigable lake would not be a necessary feature.

While further detail work should be carried on by the parties in the field to more fully settle questions of minor detail, the essential and basic facts have been secured from the investigations sufficient to enable proper consideration to be given to the general plan.

After the essential facts in relation to the sub-formation of the Chagres valley had been obtained, the diamond-drill parties were assigned to the work of systematic borings along the central line of the canal axis, in order to determine the character of the formation to an elevation of 50 feet below the level of the sea, the first borings being taken about a kilometer apart, these being followed by intermediate borings, which, it was planned, were to continue until the formation was thoroughly explored along and adjacent to the axis of the canal; supplementing and perfecting the system of borings which had been carried on by the French engineers with the same purpose in view. The results thus far obtained indicate great irregularity in the geological formation of the Isthmus.

For a few hundred feet in the Culebra cut, basaltic rock exists. The surface of this rock, however, descends rapidly towards the Pacific and is not continuously found above the line of 40 feet below the sea-level. Northward of the dividing ridge at Culebra the stratification gradually changes to slate, and later to shales and clays; while near Obispo, considerable of the pudding-stone and conglomerate formation is encountered.

Practically no regular stratification exists. Occasionally, perpendicular ledges of hard rock a few feet in thickness form dikes extending at right-angles across the canal axis. While occasional trap, and also lime and sandstone formations, were found at irregular intervals, there is no continuous regular rock formation above a line of 40 feet below the sea-level northward of Culebra, slate formations, shales, clays, sand and gravel forming the greater mass of the material.

During the progress of the surveys in the Chagres valley, a party of topographical engineers under the direction of Mr. Ruggles was at work exploring and carefully mapping the topography of the country between Obispo and Pedro Miguel, covering the section of the canal from the point where it left the valley of the Chagres through the Continental divide, and entered the low-lands of the sea-level section in the valley of the Rio Grande on the Pacific slope. The object

of Mr. Ruggles' surveys and investigations was to determine whether or not the French location could be improved upon, and also to ascertain the quantities of material to be excavated in accordance with all of the various plans under consideration.

The investigations of Mr. Ruggles determined the advisability of adhering to the location of the central axis of the canal as adopted by the French.

During the year, the various hydraulic and meteorological observations which had been taken under the French administration were continued, and the compilation and analysis of these results was assigned to Mr. Arango, member of the Am. Soc. C. E., who had charge and was at the head of the bureau controlling this part of the work.

The construction work at Culebra, using the French machinery and organization which was at hand, was continued under the charge of Mr. A. C. Harper, resident engineer, until November, 1904, when the services of Mr. W. E. Dauchy, formerly chief engineer of the Chicago, Rock Island and Pacific system, were secured as division engineer, and the organization both of technical studies and construction, incidental to the excavation through the Continental divide, was placed in his hands. Mr. Dauchy also acted as chief engineer at times when I was absent from the Isthmus.

It goes without saying that a straight and level line is preferable *par excellence* in the location of any line of communication, whether it be a ship canal, railroad, highroad, footpath, or even a telephone or telegraph line. In the construction of any line of communication, a straight and level line is never varied from, except to surmount or get around obstacles; the extent of deviations, vertical and horizontal, being controlled by the questions of time and cost. It is obvious that, other things being equal, the location should follow the line of least resistance as represented by interest on first-cost, plus maintenance and operating charges, and considering the value of time consumed in passage.

The time required to construct should also be considered. In order to determine the comparative merits of any of the various plans, it would seem as a prime requisite that the value of units of accomplishment, both as to time and cost, should be arrived at as accurately as possible. While an assumed value of these units might serve for comparing time and cost of the different plans, I considered it highly advisable, if possible, to secure data from actual work.

As the work of excavation under way by the French could be carried forward without interference with any future plan of work

which might be decided upon, it seemed highly important to continue it and demonstrate by actual work, the elements of cost and the efficiency of the various appliances and methods along the following lines to the end:—

First; that the methods used be such as would enable the maximum number of excavating units, of maximum capacity per unit, to be employed.

Second; that in selecting the various appliances, the measure of utility should be the quantity of output and cost per unit.

Third; that no appliances or methods be used which actual experience had not shown to be efficient.

When a thoroughly competent, able, and efficient organization is at work on the Panama Canal, and the work is going forward at the maximum rate of progress possible under all the circumstances surrounding the situation, the larger part of the work will have been accomplished; and the results of the first or second year's work cannot be fairly measured by the yardage of material removed.

This work was carried on during the year and expanded to such an extent as the many difficulties in the way of securing men and material would permit.

The result of the experimental work between May 4, 1904 and January 1, 1905—eight months—was the excavation of 243,472 cubic yards of material, an average of approximately 30,000 cubic yards per month, at an average cost of 55 cents per cubic yard, the output varying from 27,000 cubic yards in May to 43,000 cubic yards in December; maximum cost per cubic yard being 68.6 cents in May and the minimum cost being 50 cents per cubic yard in December. The elements which entered into such costs were those which would necessarily be assumed by any contractor doing the work, and did not include the administrative or engineering expense which would be necessary, whether the work was carried on by contract or hired labor under direction of governmental supervision.

During the next three months, ending March 31, 1905—the dry season—278,680 cubic yards were excavated at an average cost of 45 cents per cubic yard, the maximum output being 133,000 cubic yards in March at a minimum cost of 43 cents per cubic yard. These figures, however, included an arbitrary of 6 cents per cubic yard, to cover the average cost of new plant and installation, this multiplied into the number of cubic yards to be excavated from the central cut being considered sufficient to absorb the entire cost of new plant and equipment needed in the work, and also the rebuilding of such of the old French plant as could be utilized.

The result of the three months work, April, May and June, 1905, however, shows the amount excavated to be 279,589 cubic yards at an average cost of 75 cents per cubic yard.

In order to analyze the result for the last three months it is necessary to consider each by itself. In April the output was 126,750 cubic yards at an average cost of 52.5 cents, the rainfall during this period being 3 inches. In May the output decreased to 76,000 cubic yards, and the cost increased to 84 cents, the rainfall being 13 inches, an increase of 10 inches. In June the output was 77,000 cubic yards, cost $1.03 per cubic yard, and the rainfall was 7 inches.

The increase in cost in May and more particularly in June was due to the combination of many causes culminating in June. The establishment of the eight-hour day and general increase in compensation, the unbalanced condition of the forces due to the difficulty in obtaining men promptly in the proportion needed for the different parts of the work, the necessity of providing men for future requirements, aggravated by the constant leaving of employes discouraged with existing conditions—but more particularly due to the fact that labor and material was not furnished in sufficient quantities to carry out the preparatory work necessary to be performed during the dry season, December to April, in order that the work might be economically and efficiently conducted and carried forward during the wet months of the balance of the year.

This, of course, was aggravated by the fact that the French engines, cars, tracks, and appliances, were not satisfactory for the efficient conduct of the work. The long and ridged wheel base of the French and Belgian engines, in combination with the short track rail of high section, together with the necessity of operating over poorly ballasted tracks, caused an extremely large number of derailments, preventing the proper supply of empty cars to the various steam-shovels and their removal when loaded; consequently the steam-shovels were operated at one-half of their practical ordinary capacity —less than one-fourth of their theoretical efficiency.

With proper auxiliary machinery and appliances, and with sufficient suitable track facilities in connection with the American steam-shovels, the amount of output would have been limited only by the number of steam-shovels at work, multiplied by their full practical capacity, which would naturally have resulted in a largely increased output and a reduction in the cost, even as compared with the result obtained during January, February, March, and April.

It is not to be expected that more favorable results will be obtained, either in quantity or cost, until the next dry season, as compared with

the results of the three months ending June 30, 1905, unless the expansion and building up of the construction departments be discontinued and the work carried forward on a small scale, retaining the more experienced men and working only those steam-shovels which are served by track systems in the best condition, using such of the engine and car equipment as is best adapted to the work.

However, the cost per cubic yard during the next few months is mainly important to determine the experimental value of the various elements affecting the work. It may be interesting to note here that the total output for the fiscal year ending June 30, 1905, was 741,644 cubic yards at an average cost of 58.6 cents.

Under the direction of division engineer Maltby, into whose charge were given the sea-level sections of the canal and the harbors at Colon and La Boca, French dredging plants were overhauled and put into commission to enable such dredging to be done as would permit access to be maintained to the wharfs at La Boca on the Pacific end, and Cristobal Colon on the Caribbean end of the canal. These two plants developed a working capacity each of approximately 2,500 cubic yards per day, at a cost of less than 10 cents per cubic yard.

Plans were made for increased wharf facilities at both Cristobal Colon and La Boca, the execution of which, however, was delayed by the non-receipt of proper material.

Time and space will not permit of a detailed description of the large amount of preparatory work carried on under the various bureaus and sub-departments, particularly in the mechanical and machinery department, overhauling the French machinery; the planning and arranging for the construction of new shops and the installation of machinery, for the rebuilding of French engines, cars and other equipment; and the general work of maintaining and repairing plant during the future progress of the work.

Over-conservatism on my part may have induced me to overestimate the value of results obtained from actual practice, but it was considered that if a record of the cost of every function of the work were properly recorded and tabulated, the data obtained therefrom would be valuable in making estimates for the consideration of general plans, and in the determination of various questions which would arise during the progress of the work, as to the relative efficiency of the machinery, appliances, organization, methods, and men.

The system of daily and monthly cost-sheets with explanatory reports put into effect, was such as to give the fullest possible information as to the efficiency and progress of the work. The cost of each function and all the details subordinate thereto were tabulated.

Comparative costs of operation of each excavator and steam-shovel were shown separately—also the cost of excavation and removal of various classes of material; cost of operating different dumps; operating over each separate system of tracks, and the different distances; cost of work performed by different groups of men, all based on the unit cost per cubic yard. In the transportation work the cubic yard moved one mile—practically equivalent to the ton-mile—was the unit considered.

The perfection and extension of this system of unit cost was designed to enable a careful analysis to be made of the relative efficiency as above stated, and would not only give the chief engineer in control the knowledge necessary to supervise properly the work in general, but would also tend to create a spirit of emulation among the different branches of organization and the individuals composing them. Its proper use and application should have a material effect in reducing costs and expediting the work.

The day is gone by when the efficiency of organization, machinery, appliances, methods, and men can be determined simply from general observation. In works of great magnitude, the system of exact records and a scientific analysis of results based on some comparative units of efficiency should be adopted.

As cost and time will be the determining elements in the consideration of final plans, the lower the unit of cost and the greater the amount of output per unit of time, the more efficient the result; and it is to be presumed that if the best form of a canal can be constructed within a reasonable length of time and within a certain limit of cost, the American people would desire its adoption; but on the other hand, there is perchance a limit of cost and time beyond which the American people would not desire to go, even to secure the Panama Canal.

While requisitions were made for a large amount of American machinery, tools, appliances, material, and also the necessary labor to render these available, the lack of information furnished the engineers on the Isthmus as to when requisitions would be filled, or whether they would be filled at all, in whole or in part; the irregularity and slowness of shipments; and the failure to furnish all of such articles as were needed to co-ordinate properly any of the functions of the work, practically rendered ineffectual the efforts of the chief engineer and his construction staff to make satisfactory progress.

Prior to and during the early part of the dry season, when the maximum men and material should have been furnished, neither were supplied in sufficient or properly related quantities.

The efforts of the Commission at Washington were evidently so

hampered by the legal requirements controlling the purchase of supplies and the disbursement of Government funds, that—regardless of the individual ability or inclination of the separate members—results seemed impossible of accomplishment. The situation was still further aggravated by the fact that the Commission seemed unduly apprehensive of possible newspaper criticism, or of Congressional investigation, and either consciously or unconsciously permitted this feature to retard prompt action, although the individual members seemed each and all inspired with an earnest desire that the work should satisfactorily progress.

The difficulty in the way of securing material and labor promptly prevented the installation of any American steam-shovels before the latter part of 1904, so that it was not until January, 1905, that an appreciable advantage was derived from their introduction. While the chief engineer used his utmost endeavor to secure the equipment of the work with modern American appliances, steam-shovels comprised practically the only American machinery available during the year ending June 30, 1905.

As the result obtained during the rainy season, which extends from May to December, will always depend upon the work accomplished during the dry season, it should not be expected that immediate benefits so far as actual construction accomplishment would result from the reorganization of the commission in the month of April, 1905; and its functions will necessarily be confined to the determination of plans, organization, methods, and the securing of necessary labor, material and supplies, so that preparation may be fully made to take the utmost advantage of the next dry season.

The experience of the past year will have been wasted unless the controlling authorities at Washington are able to break away from the moss-covered traditions of Governmental control, applying ordinary and common-sense methods to the accomplishment of the work, and Congress shall enact legislation enabling this to be done.

The so-called "free hand"—with the rest of the body and limbs tightly bound with red-tape—can perform but limited functions.

It is not within the province of this article to go into details, but it should be plainly evident that Governmental methods which require from ten to twelve years to complete a structure such as the Federal building in Chicago—which, under private individual ownership and control could have been erected in the space of a single year, at most two—cannot be applied to the construction of the Panama Canal with satisfactory results, if the present generation is to derive benefit from its accomplishment, and at reasonable cost.

A WEST AFRICAN RAILWAY; THE SIERRA LEONE LINE.

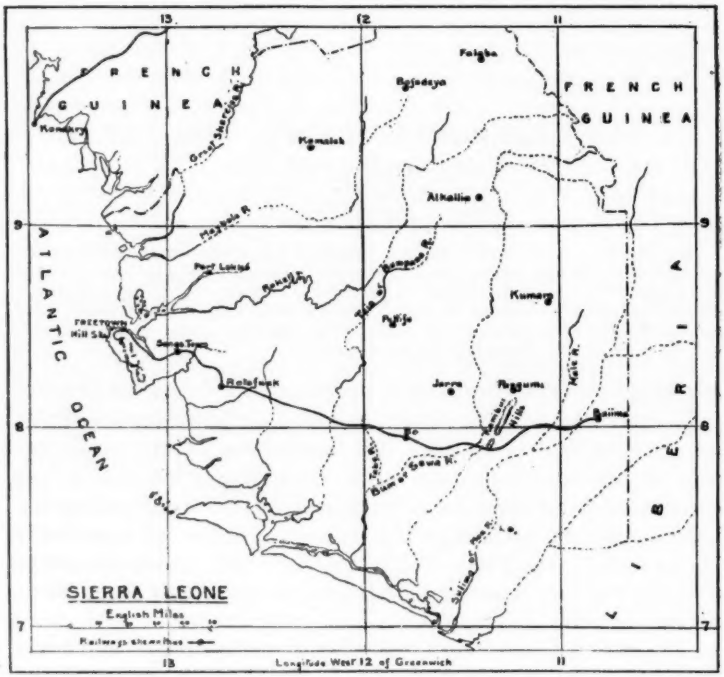
By J. Hartley Knight.

The pioneer project described by Mr. Knight in this number may be interestingly compared with the vast scheme for a Continental African railway which was his topic last month. The Sierra Leone line is one of the pathways by which commerce is penetrating toward the interior of Africa from the West Coast, and the story of its building throws some interesting side lights on the influence exerted on the future of the region and upon its inhabitants.—The Editors.

THE Cape-to-Cairo Railway project, which I had the pleasure of reviewing in a recent issue of The Engineering Magazine, has seized upon the imagination of the world, not only as the bold conception of a remarkable mind, but as an example of Great Britain's courage and enterprise in opening the Dark Continent to civilization and commerce. When we come to the West Coast, however, we find England no longer leading the van in matters of railway construction; France, in especial, is there far in advance of her.

The reason is not far to seek—France and Germany encourage the construction of railways by means of substantial grants to the promoters thereof, whereas the Imperial Government of Great Britain apparently acts on the principle of letting the railways build themselves. All things considered it is, however, greatly to the credit of a few far-sighted men like Mr. Frederic Shelford, the associate of Sir Benjamin Baker, that British West Africa is able to make so good a show as she does to-day in the matter of railway development. Given the same facilities as her neighbours, there is not the smallest doubt but that British West Africa would long ago have been an "easy first" instead of a "second best" in this direction, and instead of a total mileage of less than 600 miles for the combined colonies under the Union Jack, the whole of British West Africa would to-day be able to boast a network of railways—for as regards rate of construction, at least, in that part of the world, there is abundant proof that the British engineer is able to hold his own.

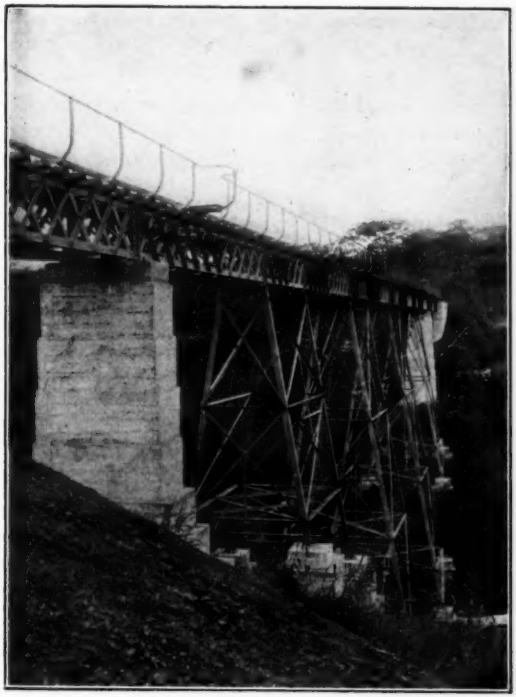
Of the 600 miles of British-built railways, 222 miles have just been completed in the colony of Sierra Leone. As will be seen from



MAP OF SIERRA LEONE RAILWAY LINE AND ADJACENT TERRITORY.

the accompanying map, the line in question—which has the distinction of being the first to be constructed in West Africa—begins at Free Town, one of the finest natural harbours on the African coast, and runs via Rotofunk and Bo, to a place called Baiima, the terminus for the time being, which is within a few miles only of the borders of the negro republic of Liberia. The gauge of the railway is 2 feet 6 inches, and it cost approximately £4,000 per mile to construct. The surveys for the line were begun in 1893, but it was not till three years later that the work of construction was actually put in hand. The work proceeded but slowly, and the first section of 32 miles to Songo took exactly two years to complete. Another section of 23 miles to Rotofunk was finished in 1900, and in the same year construction was commenced to Bo and completed a couple of years later. The extension to Baiima was begun in 1903, and was handed

over to the Government on July 31 last. Progress on the final sections of the line was at the rate of four miles per month.



HASTINGS VIADUCT.

The difficulties in the way of the constructors were many and varied. A revolt of the natives in connection with the imposition of a hut tax delayed the advancement of the line for several months, and the engineering strike in England also contributed in some degree to the delay. Sickness of the staff, due chiefly to malaria and the exceptionally heavy rainfall, which not infrequently resulted in boods and wash-outs, likewise helped to retard the work of the engineers. The first part of the route, too, was a difficult one from the engineering point of view; outside Free Town the country was practically unknown ground, and the surveys were in the nature of preliminary reconnaissances following the native paths. Fortunately there was no lack of ballast. In this respect, at least, the Sierra Leone line differs from all others in British West Africa, where ballast during construction was conspicuously absent. Mr. Shelford observed that at Lagos there is a complete absence of hard stone of any kind for nearly 60 miles from the coast, "while though hard rock does exist on the Gold Coast it is as a rule at a depth of from 50 to 100 feet, and the extraction from such quarries of the 500,000 tons of stone required for ballasting the railway was practically impossible. We had to search for

surface stones and boulders in the bush, which was at times a useless and always a laborious process."

On the first part of the Sierra Leone line the engineers' skill was somewhat severely tested owing to the exceptionally mountainous character of the district. There are eleven viaducts, most of them being over ravines from 70 to 80 feet deep; and other important works include the Ribbi bridge at mile 39, consisting of three spans of 90 feet and six of 60 feet supported on screw piles, and the Taia bridge and the Sewa bridge, which have a length of 589 and 718 feet respectively. The Moa bridge at mile 213 has eight spans and a length of 660 feet.

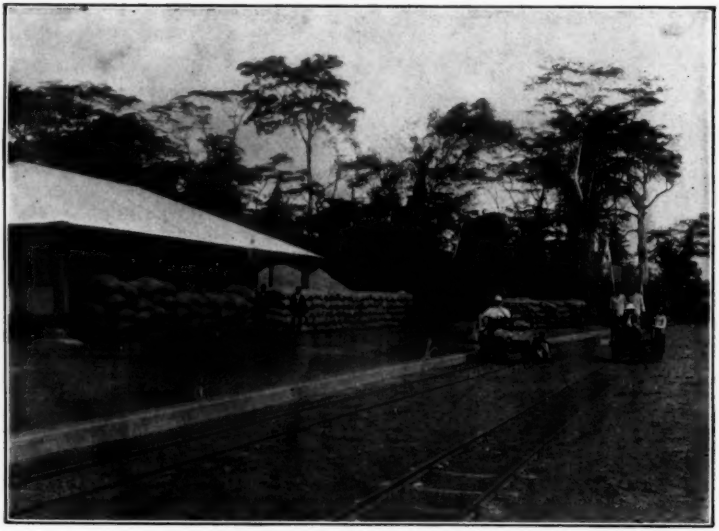
Thereafter the construction was comparatively easy, and no large earthworks have been found necessary, the line following the contour of the ground except where by so doing it would be unduly lengthened. The maximum height of banks and the deepest cuttings probably do not exceed 20 feet. Between Free Town and Rotofunk the maximum gradient used is 1 in 60 on the main line, and the sharpest curve is five chains, or 330 feet. The rails are flat-bottomed and rest on steel sleepers, timber sleepers being out of the question owing to the ravages of the white ant. The average booked speed on the railway, including stoppages, is 14 miles per hour, but this is frequently exceeded.

WELLINGTON VIADUCT, SIERRA LEONE RAILWAY.

SEWA RIVER BRIDGE IN COURSE OF CONSTRUCTION.

The locomotives all have six coupled wheels, and the larger engines have in addition a pony wheel in front and one behind. All the locomotives are fitted with a double roof to protect the driver from the sun. The first-class carriages are comfortably furnished with cane seats and a sloping back of the same material. Entrance to the coaches is obtained at either end. With the exception of some two or three brake vans for local work, the whole of the stock is mounted on bogies. The present rolling stock consists of 22 locomotives, 45 carriages, and 110 wagons, and the greater part of the stock is maintained and housed at the main depôt at Clive Town, a couple of miles from Water Street station.

The railway works have been constructed chiefly by natives under the supervision of Europeans. At first some difficulty was experienced in training the natives to this class of work, as the average West African villager is entirely unaccustomed to anything but agricultural employment in its crudest form. By dint of wonderful patience, however, the supervisors gradually educated the natives to what was required of them, and today, thanks to this training, many of the natives hold positions as carpenters, fitters, plate-layers and station-masters. In this connection the builders of the line are making some



AN UP-COUNTRY STATION ON THE SIERRA LEONE RAILWAY.

very interesting experiments. They have arranged for some West African natives to serve their time as apprentices in locomotive workshops in England, "and thus far," to quote Mr. Shelford again, "their progress and behaviour have been excellent. The only question is whether when they get back to Africa they will not be altogether too superior and allow vanity to interfere with their usefulness."

The Sierra Leone Mountain Railway is a special feature of the trunk line, and is an inestimable boon to the white inhabitants, for whose convenience, after much vexatious delay, it was constructed. It runs from Free Town to a plateau 1,100 feet above the level of the sea, and in the opinion of Mr. A. Arkell-Hardwick, author of "An Ivory Trader in North Kenia," it offers an "ideal site for a residential suburb," commanding as it does "a most extensive view, both over the Atlantic Ocean and the surrounding country, and is fully exposed to the health-giving sea breezes." For the first mile and a half the line passes through the streets of Freetown. The nature of the ground does not permit of an ascent being made until the line has crossed the Congo Stream two miles from Water Street station. The Congo Stream is spanned by a viaduct of five spans, having a length of 240 feet and a height above ground of 50 feet. The line then commences

the ascent by an average gradient of 1 in 30 until the hill terminus is reached at 5¾ miles. In many places the grade is as much as 1 in 23, one of the heavy grades having a length of a quarter of a mile. At present, I understand, there are no signals, but the trains are worked by the electric staff, the points and crossings being worked by hand from a lever alongside the track.

Although the Sierra Leone Railway has only recently been opened for its entire length of 222 miles, yet the various sections as they were built were opened as soon as completed by the construction department. The section from Free Town to Songo has now been in operation for nearly six years; traffic is developing, and before long it is confidently expected that the line will be paying interest on the cost of construction, as well as working expenses, which are already being met. The Government Railway has not been regarded in itself as a purely remunerative undertaking, but rather, I am informed, "in connection with the development of trade and prospects of the colony." The population on the latter portion of the line is known to be large, and the railway now taps the palm forest of the southwest district. Palm kernels form at present by far the largest export of Sierra Leone, the annual value being about £250,000. Much is also expected from the cultivation of cotton, although for the time being the export of this particular commodity is practically *nil*.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

By Franz Koester

IV. THE ELECTRICAL EQUIPMENT OF THE GENERATING ROOM.

Mr. Koester's series began in August last, with an analysis of the general design and construction of the central station and its adaptation to its environment and its contained machinery. His second article dealt with the steam-generating plant and accessories. His third, last month, took up the discussion of the prime movers—both reciprocating and turbine types—and their relative efficiency. The following pages conclude the subject with a summary of the best practice in installing the electrical equipment. The author's practical familiarity with the most recent work which has been done on the Continent and in the United States (for he has been intimately associated with the leading designers on both sides of the Atlantic) makes his papers especially interesting and valuable.—THE EDITORS.

ECONOMY in the electrical equipment of the generator room is not of such paramount importance as reliability of service, the former depending more directly upon the water and coal consumption in the power plant, while break-downs are much more frequent in the electrical equipment. During the last few years the voltage at the bus bars has been considerably increased, introducing many complications on the switch-board as well as in each individual piece of apparatus. Where originally ordinary hand-operated knife switches sufficed, now oil-insulated automatically operated switches are required. The measuring apparatus are interconnected by means of step-down transformers, and the bus bars as well as the oil switches are carefully located in fireproof compartments.

It is not within the scope of this article to describe the main generators selected for power and lighting stations, nor to detail the individual electric apparatus, but rather to cover the general electric equipment in modern power-plant installations.

As previously pointed out, modern practice tends toward the general adoption of electric-driven auxiliaries, viz., water and air pumps, exciter sets, etc. Individual electric-motor drive for the machinery of the boiler house, such as coal and ash-handling apparatus, stokers, draught fans and economizers, scrapers, etc., has long been recognized to be the best practice. Their low first cost and cost of maintenance, the little attention required for operation, and the cleanliness as well as several other advantages of electric driving will probably in the near future be recognized even by those power-plant designers

who yet cling tenaciously to the steam-driven auxiliaries. To engineers fearing a break-down in the electric equipment it may be said that almost similar danger exists in connection with the mechanical equipment. In both cases provision must be made to reduce the liability of failure to a minimum, and also to cut out any defective section easily. The relatively higher efficiency of the electric-drive system may be easily comprehended when it is pointed out that a 7,500 horse-power unit may operate with a steam consumption of some 10 to 15 pounds per horse-power hour, while a 75-horse-power pump consumes some 50 or 60 pounds, or even more—about four times that and more of the large unit, while the transmission losses from the generators are comparatively small. By eliminating the steam-driven auxiliaries, of course, additional current must be furnished either from the main generator unit or from a steam-driven auxiliary generator. The exciter may be driven direct from the main generator, either by gearing or belting, or where high-speed prime-movers (such as turbines) are adopted, it is considered good practice in Europe to mount the exciter directly on the main shaft.

When the individual motor-drive system is adopted, a storage battery should always be installed to supply power in case of a break-down (the cause of which may be either inside the plant itself or outside on the line) unless the auxiliary generator is steam-driven and the current kept an entirely distinct system from the main line. Besides this, the presence of a storage battery in the power house is also invaluable in case of severe short circuit when it is always ready to take the load of exciting the main generator or lighting the power house. The battery is also desirable during a heavy load for maintaining a steady voltage on the exciter bus bars. As the storage battery is often employed for the operation of the automatic switches, it might as well be installed of sufficient capacity to supply power in case of emergency.

A similar system will be installed in the most modern Continental plant—the St. Quen plant of Paris, the normal output of which will be 20,000 kilowatts—and as all the auxiliaries will be operated by electric motors, a storage battery of 1,300 ampere-hours will be installed. In addition to operating the pumps, this will also furnish exciting current in case of emergency. For the ordinary excitation of the four 5,000-kilowatt turbo-generators, one 300-kilowatt turbo-generator of 200 volts and 2,700 revolutions will be installed. In addition to this there will be two motor-generator sets of 375 kilowatts each operating in multiple with the above battery.

At the new plant for the Interborough Rapid Transit Company of New York, five 250-kilowatt generators are installed to supply exciting current and to operate motor-driven auxiliaries such as coal-handling apparatus, stokers, etc. The entire auxiliary system other than this—as water and steam pumps—are steam driven. Two of these dynamos are steam-driven, while the others are motor-driven; all of them work in multiple with a storage battery of some 3,000-ampere-hours capacity.

FIG. 70. BOOSTERS IN A HAMBURG CENTRAL STATION.

Although cost of installation and maintenance is great, the storage battery is usually a paying investment—depending of course on the type of service. This may be said not only of large power plants, but of small plants as well. On the continent of Europe one will have difficulty in finding a plant where the storage battery has been omitted. In small industrial towns having their own direct-current central stations furnishing power in the day time, and at the same time charging the battery which furnishes current for lighting at night, the battery is designed so as to be able to supply part of the power at the peak during the day. One of the Hamburg direct-current plants previously mentioned has a total engine capacity of 5,600 kilowatts and a storage battery of 1,250 kilowatt-hours capacity. The booster for this battery is illustrated in Figure 70.

The value of the storage battery may be easily seen from the accompanying chart, representing a load diagram on the San Francisco, Oakland & San Jose Railway Company's power plant, where "chloride accumulators" operate in parallel with the generators on the

railroad line. It will be noticed that the minimum current is about 180 amperes, while the maximum is about 2,200. The division of the load between the battery and the generators is also shown in this chart, and the fluctuation of some 1,200 amperes is taken care of by the battery. Although today there are not many who advocate direct-current power plants for long-distance transmission, for railroading or even lighting, the need of a storage battery is still urgent in the central station and in the sub-station when continuous current is employed on the railway motors; but this does not come within the province of this paper.

In large power houses a specially built annex at the side of the generator room, for switching and measuring purposes, is of great convenience, but where space for this is not available, a part of the generating room should be set aside for this purpose only, as it is not good practice to locate the switch-board near the mechanical side of the plant, the high-tension cable and steam pipes (both usually carried under the engine room floor) being too liable to interfere with each other. The end wall of the generating room in a large power plant is seldom large enough to accommodate the entire bus-bar and switching system, and therefore space running at the side of the generating room farthest from the boiler room may be utilized for this purpose. The main bus bars may be located below the floor level of the engine room, but the controlling switches should be placed preferably in the gallery from which the generating room is easily overlooked.

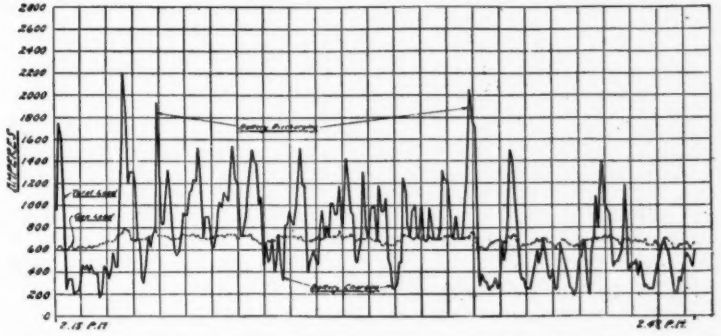


FIG. 71. LOAD DIAGRAM, POWER PLANT OF SAN FRANCISCO, OAKLAND, AND SAN JOSE RAILWAY CO.

A flexible wiring system and a well arranged switch-board are of the greatest importance to insure a steady operation of the power plant; the requirements are similar to those in the steam-pipe equipment. To be too economical in this direction, as in omitting fuses

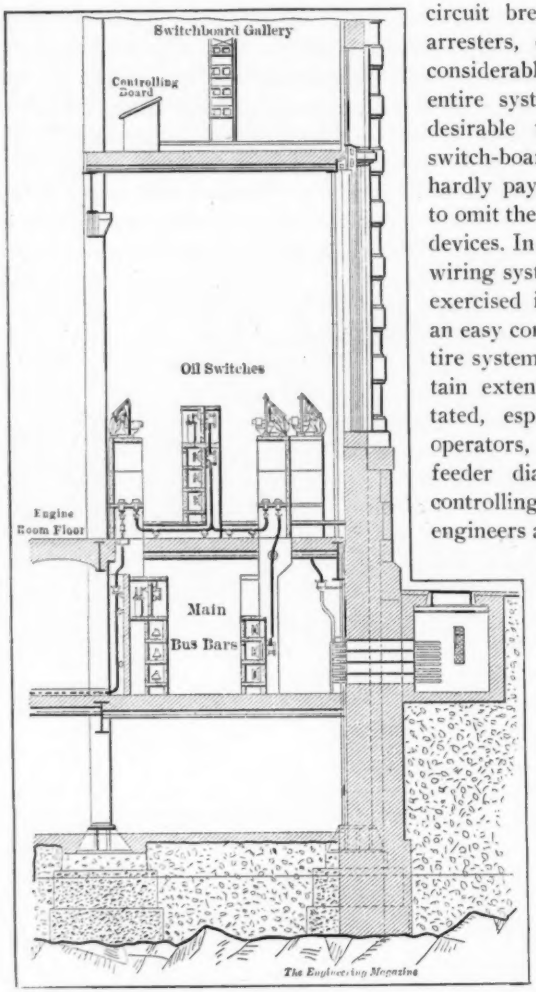


FIG. 72. SECTION OF INTERBOROUGH COMPANY'S POWER HOUSE, 59TH ST., N. Y., SHOWING SWITCHING ARRANGEMENTS.

circuit breakers, lightning arresters, etc., may cause considerable damage to the entire system. It may be desirable to simplify the switch-board, but it will hardly pay or be advisable to omit the necessary safety devices. In complicating the wiring system care must be exercised in order to have an easy control over the entire system, which to a certain extent may be facilitated, especially for new operators, by placing a feeder diagram near the controlling devices. Many engineers are of the opinion that complicated machines or systems are more liable to break down than simple ones, but practice has often proven the contrary, provided a proper design is secured. It is certain, however, that they require a more skilful attendance.

Modern high-tension apparatus is of considerable size and complicated so that it would not be desirable to crowd it behind the switch-board; this is also undesirable on account of the high potential (step-down transformers are located between bus bars and measuring instruments). It is general

practice to have this part of the apparatus located in another part of the plant, rather than at the switch-board itself. The feeds from the generators may lead direct to the bus bars, which may run the entire length of the generating room, while the switches are operated from a centrally located board from whence all distant apparatus is easily controlled. The main bus bars (of which two sets are generally desirable) are located on the main generating-room floor, or below it, where the high-tension switches are also located. The bus bars and switches are placed in separate fireproof compartments. The switch-board and controlling board are located above in the gallery, from whence the high-tension switches are operated, either electrically, mechanically or pneumatically. An example of up-to-date American practice is given in Figure 72, showing sectional views of the New York Interborough Rapid Transit Company's Subway power house. It will be noticed that the main bus bars are placed in the gallery beneath the main generator-room floor, while the oil switches are located in a gallery above. While the bus bars run the entire length of the building, the switch-boards occupy only a small space. A diagram showing the main bus bars and group switch arrangements is given in Figure 75. The complete wiring system, which will be seen in Figure 74, explains itself. Another wiring system, that of one of the twin municipal plants of Vienna is shown in

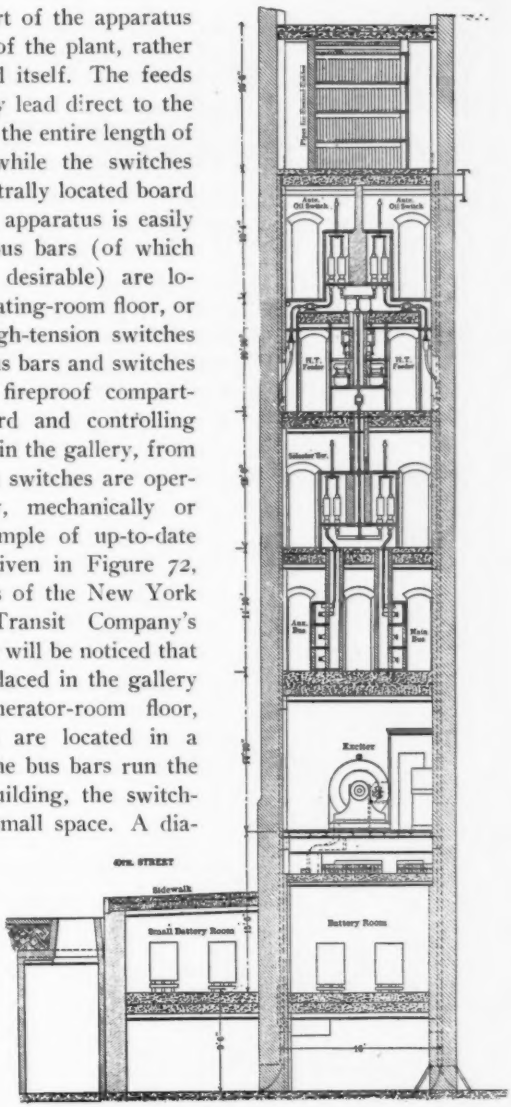


FIG. 73. TYPICAL MODERN HIGH-TENSION (10,000-VOLT) SWITCHING ARRANGEMENT, WATERSIDE POWER PLANT, N. Y. EDISON CO.

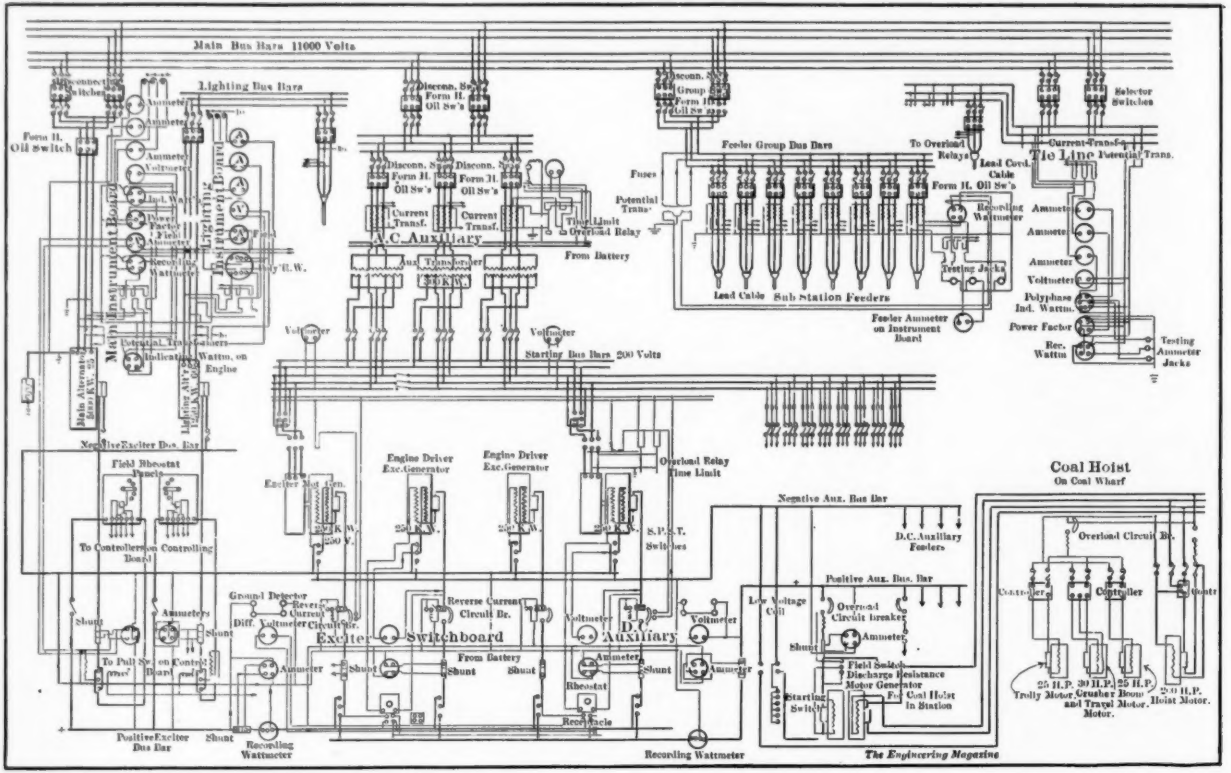


FIG. 74. GENERAL WIRING SYSTEM, 59TH ST. POWER HOUSE OF THE INTERBOROUGH CO., NEW YORK.

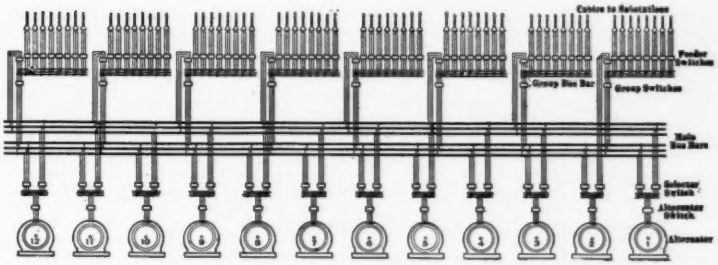


FIG. 75. DIAGRAM OF 15,000-VOLT CIRCUITS IN N. Y. SUBWAY POWER PLANT.

Figure 76. The instrument board of the former plant is of vertical steel construction faced with black marble panels, while the controlling board, a diagram of which is given in Figure 77, is constructed in the form of a desk, arranged and installed similarly to that shown in Figure 78, which illustrates an alternating-current and direct-current switch-board in a plant in Mexico, installed by the General Electric

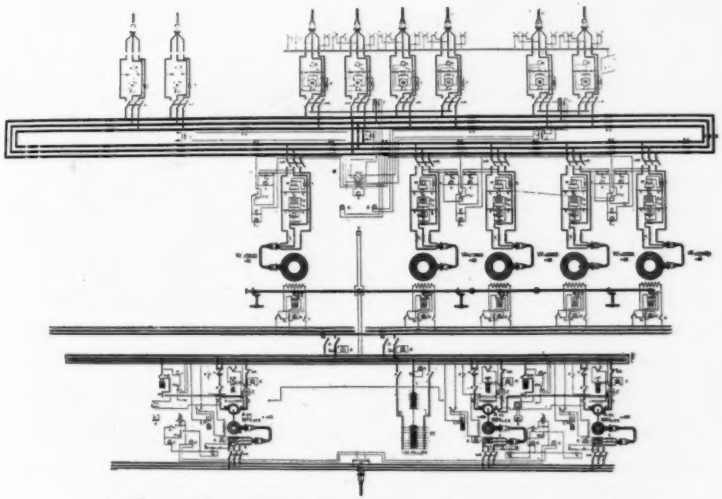


FIG. 76. WIRING SYSTEM OF TWIN MUNICIPAL PLANTS, VIENNA.

Co. The main oil-switch motors are operated from a storage battery at a potential of 110 volts. In connection with each controlling switch is installed a red and green bull's-eye lamp indicating the position of the switch. As will be noticed in the diagram of the controlling board,

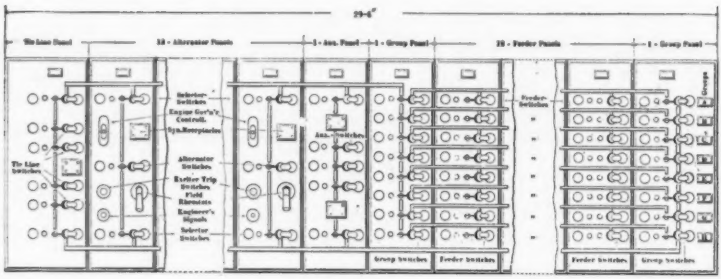


FIG. 77. DIAGRAM OF CONTROLLING BOARD, N. Y. SUBWAY POWER PLANT.

it is divided into two sections, one for the current from the generators to the buses, and the other between the buses and sub-station feeders. The oil switches which are now commonly used are placed

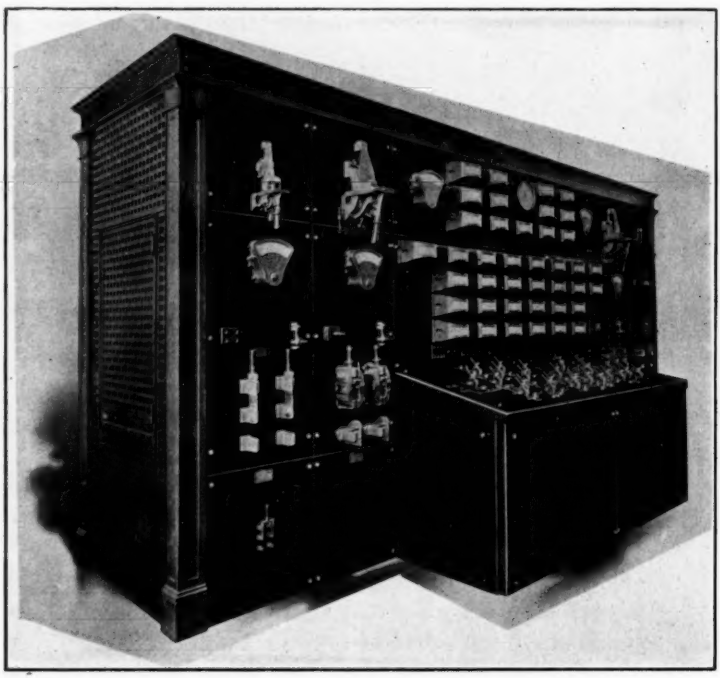
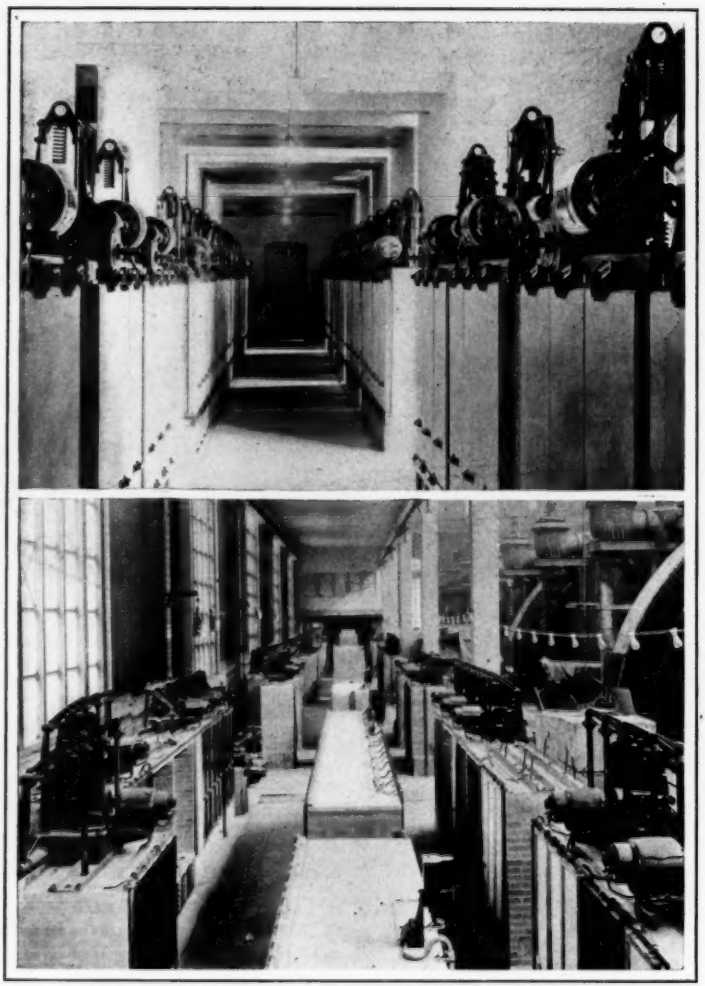


FIG. 78. 50-CYCLE ALTERNATING AND DIRECT-CURRENT SWITCH-BOARD FOR NECAXA POWER PLANT, MEXICO.

FIG. 79. A MODERN AMERICAN POWER STATION; PHILADELPHIA RAPID TRANSIT RAILWAY, 2ND ST. AND WYOMING AVE.

Showing four of the six 1,500-kilowatt Westinghouse turbo-generators installed, with engines of the old type in the background.

in fireproof compartments of either brick or concrete, the front openings being closed with either slate or soapstone slabs, or in some cases wired glass. In regard to the latter it may be noted here that in case of short circuit one is as liable to rupture as the other. The use of small electric motors for the operation of these switches is the most common American practice, while on the continent of Europe mechanical systems are more frequently found. The former system as developed by the General Electric Co. is illustrated in Figure 80 representing the apparatus in the switching room of the N. Y. Edison Co.'s water side power station and in that of the New York Subway power station. In both of these cases the six-pole switches are located entirely in a common compartment while in Figure 83, showing the interior of the compartment of a General Electric 30,000-volt oil switch, each phase has its own compartment. Another type of oil switch, mechanically operated, is illustrated in Figure 84, which represents a 40,000-volt (and higher) Brown Boveri



FIGS. 80-81. THE UPPER VIEW SHOWS THE OIL SWITCHES IN THE NEW YORK EDISON CO.'S PLANT, 38TH ST. AND EAST RIVER, N. Y. THE LOWER SHOWS THE OIL SWITCHES AND BUS-BAR COMPARTMENT IN THE 59TH ST. STATION OF THE INTERBOROUGH RAPID TRANSIT CO., N. Y.

General Electric Co., Schenectady, N. Y.

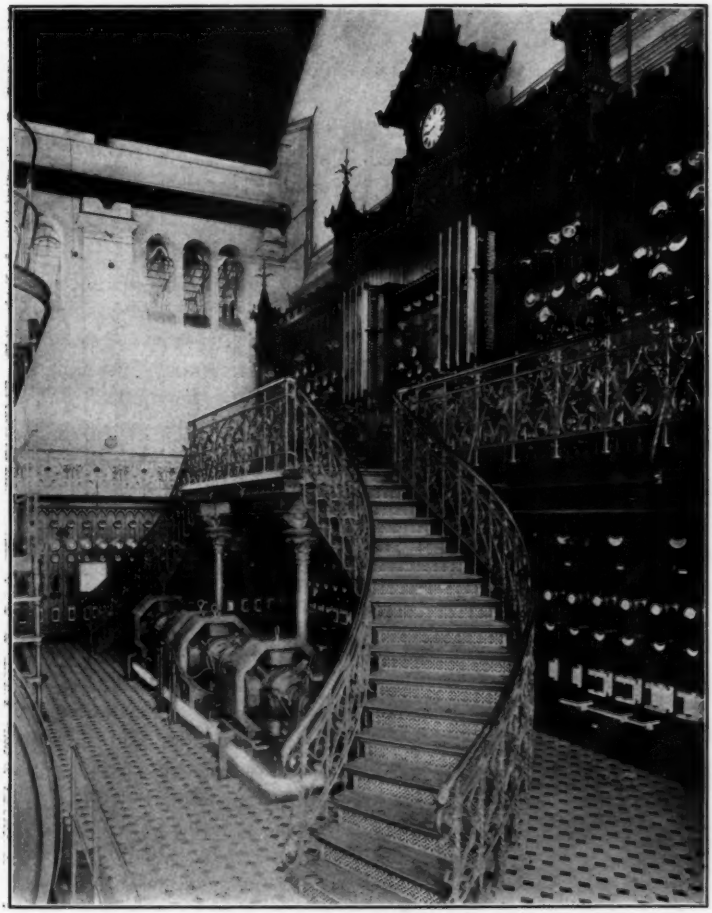


FIG. 82. SWITCH-BOARD FOR AN EARLY 600-VOLT DIRECT-CURRENT PLANT AT HAMBURG.
Schuckert & Co., Nuremberg.

switch. It will be noticed that here also each phase has its own compartment, on account of the high potential.

To the appearance of the instrument board itself, seemingly little attention is devoted in America compared to that given to this subject by the European designers. Indeed, the plainness of American switchboards is no more marked than that of the entire equipment of the

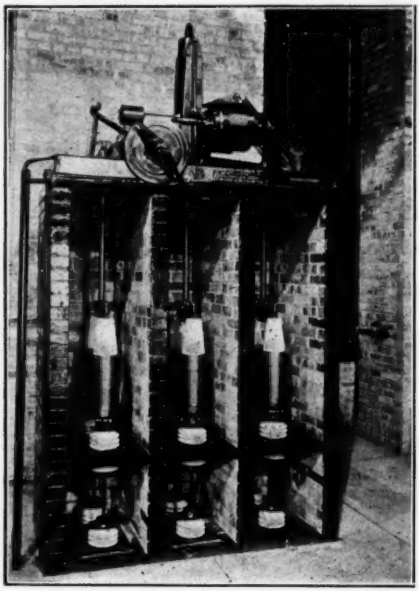


FIG. 83. 30,000-VOLT 50-AMPERE OIL SWITCH FOR OUTGOING FEEDERS.
General Electric Co.

power plants, everything in fact being designed for its utility only. I would like to suggest a more artistic design of such a structure bearing scientific instruments; the suggestion may also be applied to power-plant construction in Great Britain. Of course, the design of a switch-board as well as the entire plant, is largely a matter of taste, and undoubtedly the designer of the switch-board illustrated in Figure 82, by the Schuckert Co., Nuremberg, will have its critics (pro and con). This elaborate board is installed at the power plant "Zollvereinsniederlage," an early direct-current installation in the City of Hamburg operating at a potential of 600 volts. The later installed plants in this same city illustrated in Figure 85 have switch-boards of similar ornamental design, the frame work only, however, being constructed of wood and the panels of white marble, while in this case the board is entirely of wood and no difficulty has been experienced with its construction. It may be possible to construct boards of wooden skeleton for much higher voltages, provided that proper arrangements are made for the insulation of wiring and switches, although an iron frame with incombustible panels is far more advisable. An example of good modern continental practice is given in the Vienna plant, the switch-board of which is illustrated in Figures 87 and 88. This board is constructed entirely of iron and white marble. Another practice is to make the entire switch-board of iron, mounting the instruments directly on this frame with proper insulation. The Brown Boveri Co. have installed several of this type among which is that for the highest potential to-day employed in Europe, 40,000 volts. It is of the great-

est convenience to have one panel devoted to each generator, in order to assure easy reading and operation.

To ensure reliable and economical operation of the power plant, in the electric as well as in the mechanical part, it is most desirable to give the design the most scientific consideration and to employ skilful operators. The installation of good modern apparatus (frequently called troublesome or complicated) not necessarily including labor-saving devices, has daily been proven on the continent of Europe to be most economical and advantageous, although its first cost and also the cost of maintenance be seemingly large. The results of this practice I have endeavored to show in examples especially in the preceding articles of this series (steam part of the plant) where economy is of greater importance and more often lost sight of—for example, the production of one indicated-horse-power hour for 9 to 10 pounds of water as against 13 to 15 pounds.

This is of course due not only to the progressive spirit and engineering skill of the manufacturer, but to a great extent depends upon the ability of the power-plant designer and the operator.

All tests in connection with the operation of the plant, whether satisfactory or otherwise, should be reported in the technical press, to give opportunity for criticism by competent engineers; this works not only for the general engineering advantage, but finally results in the manufacturers' material benefit.

Indeed, the spirit and policy of publicity is generally characteristic of the best modern practice, whether in the construction or

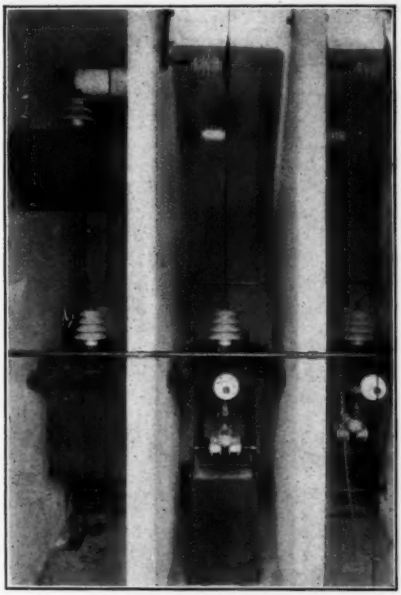


FIG. 84. 40,000-VOLT MECHANICALLY OPERATED OIL SWITCH.

Brown Boveri & Co.

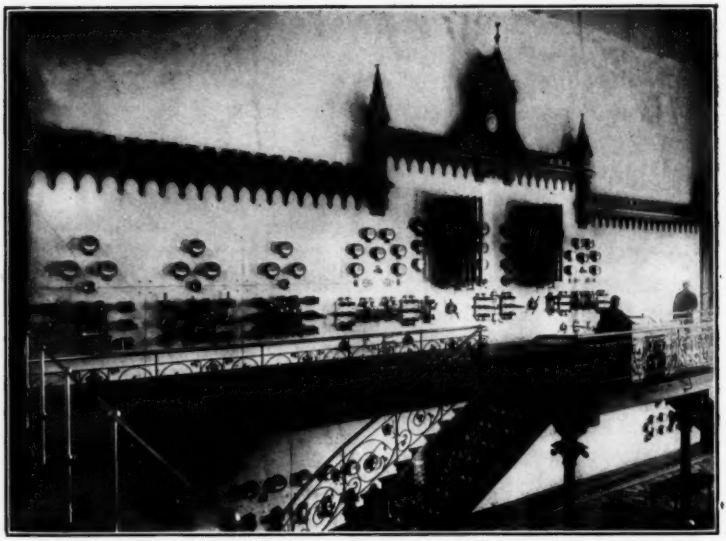


FIG. 85. SWITCH-BOARD AT THE "BILLE" CENTRAL STATION, HAMBURG.
Schuckert, Nuremberg.

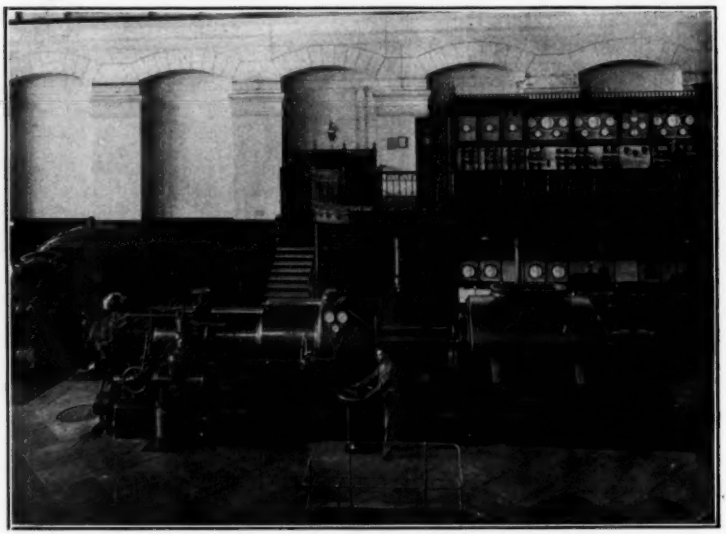


FIG. 86. PLANT OF THE SOCIETA ALTA ITALIA, TURIN.
The switch-board is seen in the gallery. The Brown-Boveri-Parsons turbines are of 2,250 horse power.

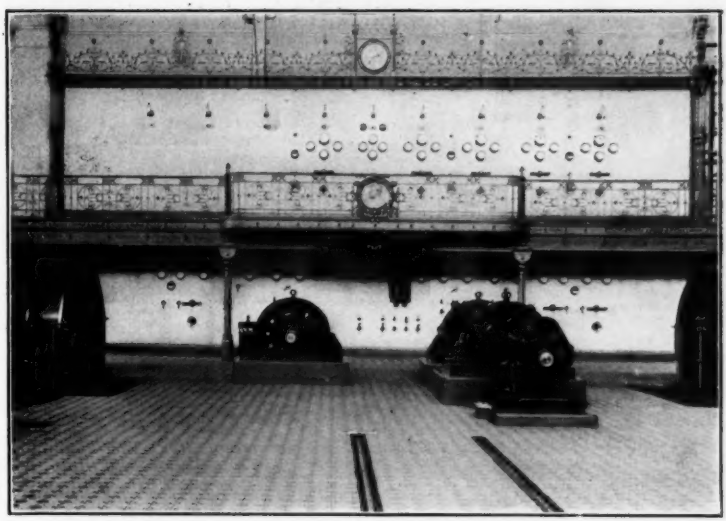


FIG. 87. MODERN SWITCH-BOARD IN THE VIENNA POWER PLANT.
Designed by the Siemens-Schuckert Co.

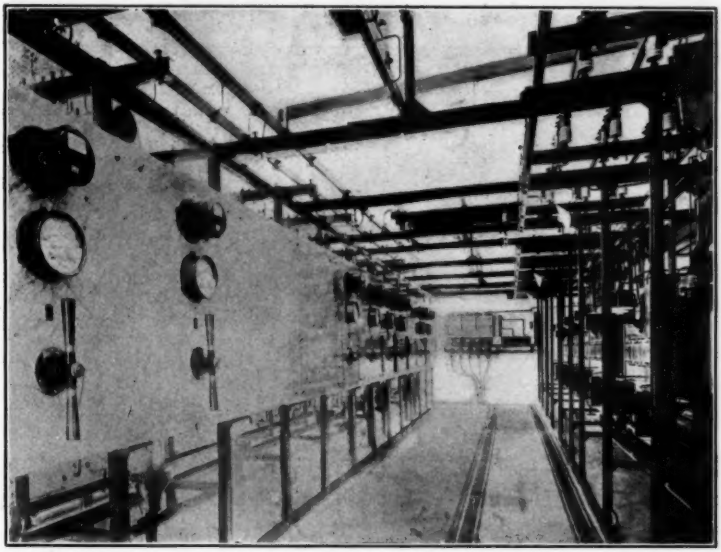


FIG. 88. REAR OF SWITCH-BOARD GALLERY, SHOWING BUS BARS, VIENNA POWER PLANT.

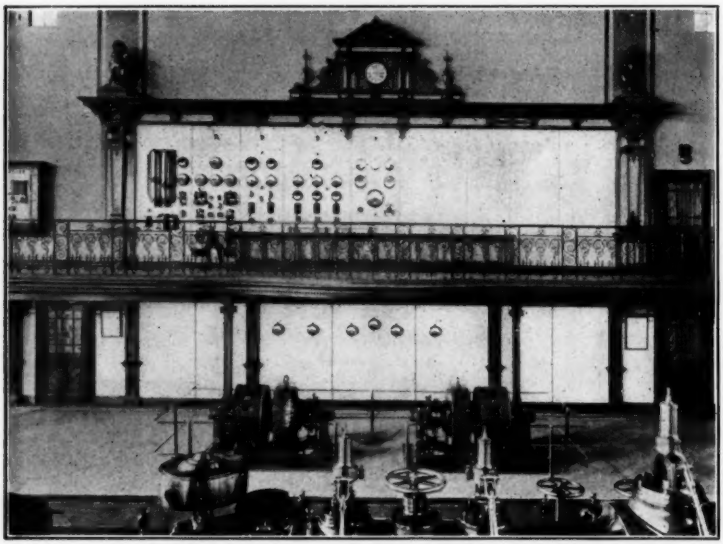


FIG. 89. SWITCH-BOARD AT THE CENTRAL STATION IN MAINZ, GERMANY.
In front of it are seen two rotary transformers. Siemens-Schuckert Co., Berlin.

FIG. 90. BOW STATION, CHARING CROSS AND CITY ELECTRIC CO., LONDON.
Showing switch-board in background. Sulzer cross-compound horizontal engines; 10,000 horse power in four units.

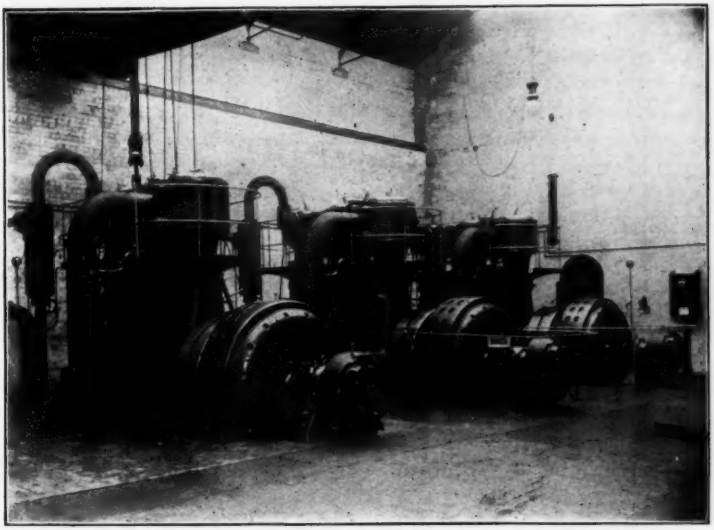


FIG. 91. LEEDS AND WAKEFIELD TRAMWAYS POWER HOUSE, ENGLAND.

Three triple-expansion engines built by Messrs. James Hawden & Co., each coupled direct to a 400-500 kw. generator by Messrs. Dick, Kerr & Co., Ltd.

operation of engineering works. Those who have the most to give are usually the freest in giving out information of this kind. Apparently, also, the broad-minded policy brings its own reward, in that the data it supplies to professional workers, falling upon fertile ground, are taken up and cultivated by many minds, and return to the sowers eventually a harvest many fold greater in value than the original seed.

It remains for me to express thanks to the numerous companies, both in America and Europe, for the illustrations which they kindly furnished regarding modern power-plant designs and economics.

THE MINERAL INDUSTRIES OF THE UNITED STATES

By Edwin C. Eckel.

Mr. Eckel is strikingly successful in bringing out clearly the proportionate importance of the various products of the mine—metallic and non-metallic. He avoids all monotony of figures, and makes the facts stand out in strong relief. The results will probably be something of a surprise to many readers, and perhaps the most interesting will be the enormously greater importance which is shown to attach to the mineral products immediately connected with engineering development, and the phenomenal growth of the cement industry.—THE EDITORS.

IT is difficult to estimate justly the importance of the mineral industries to the prosperity of the United States, for one is apt to be led to opposite extremes, depending on the personal point of view. On the one hand it may be pointed out that over a third of the population of the country are engaged in agricultural pursuits, while only about a fiftieth of its workers are employed in mining. If such data could be accepted as bases for comparison, it would be difficult to work out a good case for the industries which are the subject of this article. But if we recollect that a very large proportion of our manufactures are dependent on raw materials of mineral origin, that the transportation industries are largely based on the same raw materials, and that one important duty of the farmer is to feed the miner and furnaceman, the case assumes a brighter aspect.

There is danger, on the other hand, of going to the opposite extreme, and overestimating the importance of the mineral deposits and the industries which are dependent on them; and the best corrective for such an overestimate would be the examination of the comparative figures given below.

Taking the United States Census results as a basis, it is stated in the report on population that of the total workers in the United States the percentage employed in mining or quarrying has been as follows:

1880.....	1.4 per cent.
1890.....	1.7 per cent.
1900.....	2.0 per cent.

The mining interests of the country are thus increasing gradually, compared with other industries, and at present one in every fifty American workers is directly employed in either mining or quarrying.

These figures, however, hardly represent the true importance of the mineral industries, because they include only those who are employed immediately in the work of getting the crude ore or rock to the surface. A more satisfactory method of calculation would be to include, with these, the workers employed in certain industries most closely allied to mining. Blast-furnaces, coke works, salt refineries, cement mills, and similar plants are so directly connected with the mineral industries that their employees may properly be included in the calculation. In each of the allied industries just mentioned, the work being done is simply the putting of the raw material into condition for its first sale, not the preparation of a finished product.

Using this as a criterion, the following data can be obtained by careful examination of the Census reports:—

	1900.		1890.	
	Number.	Per Cent.	Number.	Per Cent.
Total workers in the United States....	29,073,233	100.0	22,735,661	100.0
Miners and quarrymen.....	580,761	2.0	387,248	1.7
Furnaces and allied industries.....	525,185	1.8	439,197	1.9
Total directly interested in mining..	1,105,946	3.8	826,445	3.6

The totals above given indicate that, of all the workers in the United States, about one in twenty-six is directly interested in the mineral industries, taken as a whole.

If the figures for the separate States be examined, it will be seen how strikingly these industries are concentrated in certain States. In Pennsylvania, for example, over 400,000 persons, representing more than 30 per cent. of the State's working population, are engaged in mining or in closely allied pursuits. The other extreme is to be found in Mississippi, where only 21 persons, out of a population of over 1,500,000, are employed in mining work. Montana, Colorado, Arizona, West Virginia, Nevada, and Idaho rank close to Pennsylvania in the percentage of their population interested in the mineral industries; but far below her in the totals, because of their smaller population.

This statement as to Pennsylvania's rank may serve as a hint toward obtaining a correct idea of the relative value of the different mineral products of the country, compared among themselves. It is not gold and silver which are of greatest commercial importance, but coal and iron; and a realization of this fact would serve to correct many misapprehensions concerning the mineral industries. We are apt to be dazzled by the high unit value of gold, and to lose sense of true proportion. We all know from personal experience that gold is

the most valuable—and scarcest—of the metals which we ordinarily encounter; we know, further, that States and territories have been populated by gold seekers, and that thousands of men are now engaged in prospecting and mining for this most precious metal. And then, by a bit of faulty reasoning, we are likely to arrive at the *very* faulty conclusion that gold must be the most important of our mineral products. As a matter of fact it is, as will be seen later, far from occupying first place.

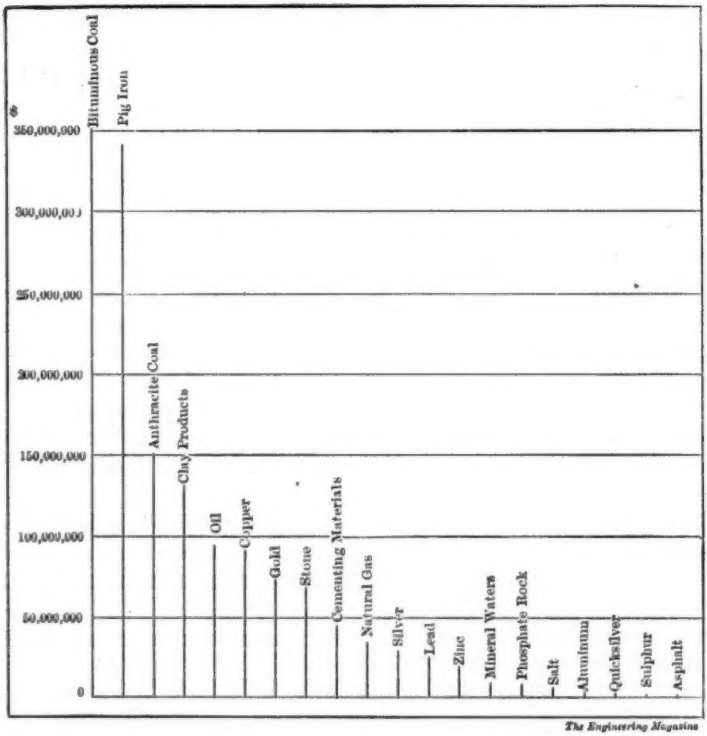


FIG. I. ANNUAL PRODUCTION OF THE PRINCIPAL MINERALS IN THE UNITED STATES.

The facts regarding the relative importance of the various mineral products are brought out most strikingly in the accompanying diagram which shows graphically their values for the year 1903. It will be seen that bituminous coal is by far the most important product, forming with pig iron a very distinct class. Below these come

another group, headed by anthracite coal and clay products, and including such diverse materials as copper, petroleum, gold, and building stone. Gold, it will be observed, ranks no higher than seventh among American mineral products; while the high rank given to bricks and building stone will probably surprise the reader.

A third group consists of natural gas, silver, lead, cement, and zinc—another heterogeneous class. Below this would come, in order, mineral waters, phosphates, and salt.

The most striking feature is that the non-metallic minerals far outclass the metals in value. Elsewhere* I have summarized this phase of the subject as follows:

> "From the purely commercial point of view, therefore, the non-metals are by far the more important of the two classes. From the point of view of human comfort, the disparity in importance is just as striking. We could contemplate with some serenity the possibility of having to live without copper—but not the necessity of existing without salt. A scarcity of gold is certainly inconvenient, but not to be compared for discomfort to a lack of fuel. With the single exception of iron, the metallic products are objects of convenience or luxury, while many of the non-metals are necessaries of civilized life."

These facts will be brought out more clearly when the different mineral products, or classes of products, are separately considered.

Mineral products are so many, and of so varied characters, that no satisfactory discussion of the subject can be attempted unless the different products are grouped or classified in some convenient fashion. This has accordingly been done in the following table, and in order to indicate the relative commercial importance of these groups, the values for the year 1903 have been computed and added:—

	Value, 1903.
Fuels	$634,233,791
Iron	344,350,000
Structural materials	219,094,500
Precious metals	102,913,700
Copper	91,506,000
Other non-metals	59,635,120
Other metals	44,864,242

Of the total value of mineral products for this year, which amounts to almost one and one-half billion of dollars, the non-metallic products contributed over three-fifths. As the first three groups above listed are of peculiar importance, both in the total value of their output and in their indirect effects on trade, they will be separately discussed in a little more detail.

Fuels.—Of the $634,000,000 produced in 1903 by the deposits of

Mining Magazine, September, 1904.

mineral fuel in the United States, considerably over half is to be credited to bituminous coal, a quarter to anthracite, about a seventh to petroleum, and one-twentieth to natural gas. This gives some idea of the relative values of the output of the different fuels. Their enormous aggregate value represents, it will be noted, about 40 per cent of the total mineral production of the country. A glance at Figure 1 will further show that the bituminous-coal output alone amounts to seven times the gold production; that anthracite outvalues gold two to one, while even petroleum has a greater total than gold and silver together.

The four products here included under the head of fuels are, as above noted, very unequal in importance. The most important by far—bituminous coal—is rather widely distributed east of the one hundredth meridian, while the territory west of that line is scantily supplied. The result of this scanty coal supply is that the iron industry is poorly developed in the west, notwithstanding the occurrence there of large deposits of rich iron ores.

Anthracite coal, whose non-smoking properties give it an importance far out of proportion to its fuel value, is developed in similar geographic fashion. Over 99.9 per cent. of American anthracite comes from a comparatively small area in eastern Pennsylvania, the remainder being produced in Colorado and New Mexico.

Petroleum and natural gas are distributed somewhat more equally. In 1903, almost one-fourth of the total oil production came from California, about one-fifth from Ohio, one-sixth from Texas, one-eighth from West Virginia, one-ninth from Pennsylvania, and one-eleventh from Indiana. A dozen other States contributed small percentages to the output. The most striking change in recent years has been the westward shifting of the oil industry, owing to the discoveries in California, Texas, and other States west of the Mississippi, coincident with decreases in the output of eastern States.

Natural gas, though widely distributed, is still supplied mostly by the middle States. Pennsylvania alone produces almost half of the total output, followed by Ohio, West Virginia, and Indiana in the order named. These four States together produce over 90 per cent of the entire supply.

Entirely aside from their value as marketable commodities, the location of fuel deposits has exerted a powerful influence on the development of the other mineral industries. An area where good coals are scarce can hardly hope to become important as an iron-producing district, even if it contains large deposits of high-grade iron ore. The

case is similar with regard to the clay, cement, and chemical industries; many extensive beds of raw deposits suitable for these industries being rendered practically valueless by the absence of fuels. Absence of fuel prevents the development of anything except high-grade deposits of precious or semi-precious metals.

On examining the next subject—iron—a very good example will be found of the control which fuel supplies exert over other industries.

Iron.—In discussing the iron industry of the United States, two distinct phases of the subject are to be considered—the mining of iron ores, and the production of pig iron. The two industries are necessarily closely related, but as will be seen later they differ very widely in geographic distribution.

The iron-mining industry will naturally be considered first. In the table below, the iron-ore production of the various States is given, in long tons, for the year 1903.

	Long tons.
Minnesota	15,371,396
Michigan	10,600,330
Alabama	3,684,960
Tennessee	852,704
Virginia and West Virginia	801,161
Wisconsin	675,053
Pennsylvania	644,599
New York	540,460
New Jersey	484,796
Georgia	443,452
Nevada, New Mexico, Utah and Wyoming	392,242
Colorado	252,909
North Carolina	75,252
Missouri	63,380
Texas	34,050
Kentucky	32,227
Connecticut and Massachusetts	30,729
Ohio	29,688
Maryland	9,920
Total United States	35,019,308

These figures can be rendered more intelligible and valuable if the States are arranged in the natural groups which immediately suggest themselves. When this is done the following results are obtained, as shown in both tons and percentages of total output:

	Tons.	Per Cent. of Total.
Lake Superior District	26,646,779	76.1
Southern United States	5,997,106	17.1
Central and Eastern United States	1,730,272	4.9
Rocky Mountain States	645,151	1.9
	35,019,308	100.0

Coal Beds ■ ++++ Iron Ore Deposits

FIG. 2. MAP OF THE UNITED STATES, SHOWING THE PRINCIPAL COAL AND IRON DEPOSITS.

From this it will be seen that the Lake district produces slightly over three-fourths of the total output; while the southern States produce about one-sixth, the central and eastern States one-twentieth, and the western States one-fiftieth. Fifty years ago such a geographic distribution of the production of iron ores would have implied a similar distribution in the production of pig iron, for at that date furnaces were almost invariably located near the mines. But at the present time this is far from being true. Transportation facilities have improved so remarkably, in certain lines, that the furnaces are now located as near as possible to the markets and the fuel supply, rather than near the mines. This is particularly true with regard to the furnaces which obtain their ores from the Lake district, since these are located chiefly in Pennsylvania, Ohio, Illinois and western New York. The Southern plants, more favored by nature, are located close to both iron ore and coal.

The 35,000,000 tons of ore produced in the United States during 1903, plus about 1,000,000 tons of imported ore, yielded 18,000,000 tons of pig iron. The distribution of the pig-iron production is shown in the upper table on the following page.

Comparison of this table with that previously given for the ores shows the remarkable differences in the localization of the two in-

PRODUCTION OF PIG IRON IN 1903, BY STATES.

	Long Tons.
Pennsylvania	8,211,500
Ohio	3,287,434
Illinois	1,692,375
Alabama	1,561,398
New York	552,917
Virginia	544,034
Tennessee	418,368
Maryland	324,570
Wisconsin and Minnesota	283,516
Missouri, Colorado and Washington	270,289
Michigan	244,709
New Jersey	211,667
West Virginia	199,013
Kentucky	102,441
North Carolina and Georgia	75,602
Connecticut	14,501
Texas	11,653
Massachusetts	3,265
Total	18,009,252

dustries. These differences are brought out still more strikingly when the States are combined in groups. In the table below this has been done for both iron ores and pig iron, the production of each group of States being given both in tons and in percentages of the total.

	Iron Ore.		Pig Iron.	
	Tons.	Per cent. of total.	Tons.	Per cent. of total.
Lake Superior district	26,646,779	76.1	528,225	2.9
Southern States	5,997,106	17.1	3,287,368	18.3
Central and Eastern U. S.	1,730,272	4.9	13,973,059	77.6
Rocky Mountain States	645,151	1.9	220,000	1.2
	35,019,308	100.0	18,009,252	100.0

The geologic and economic facts which have caused these conditions may be stated briefly as follows:—

In the Lake Superior district immense deposits of hematite occur, largely of Bessemer grade. Fuel is scarce, and the ore is therefore shipped to furnaces in the central and eastern States, via the water route of the Great Lakes.

On the western side of the Appalachian Valley, occurring at intervals from New York to Alabama, great deposits of an oolitic red hematite—the "Clinton fossil ore"—occur. These ores are particularly well developed in Tennessee and Alabama, where they are cheaply mined. In these States the Clinton ore beds are located close to beds of coal and limestone. Being rarely low enough in phosphorus for Bessemer use, the fossil ores are used for foundry iron and open-hearth steel.

In the Appalachian Valley itself, from Vermont to Alabama, large

but irregular deposits of brown hematite are found. In Virginia, Tennessee and Alabama, where fuel is within reach, these deposits have been extensively worked for foundry and basic iron.

In the Adirondacks, the Highlands of New York and New Jersey, and the Blue Ridge, deposits of magnetite are frequent. Several of these are extensively worked, but many contain prohibitive percentages of titanium or else are so lean as to require concentration.

The Rocky Mountain and Pacific States contain many large undeveloped bodies of ore, chiefly magnetite and hematite. Owing to distance from fuel and markets, and high transportation charges, less attention has been paid to these deposits than they deserve.

Structural and Engineering Materials.—Few economic movements of recent years have equalled in importance the growth of the industries based on the non-metallic structural materials. In this group are included the stone used for building or road purposes, such clay products as are used in engineering, and the various cementing materials. The production of structural materials in the Uuited States for the years 1902 and 1903 has been summarized in the following table:—

	1902.	1903.
Stone	$64,559,099	$67,960,468
Brick, tile, etc.	98,042,078	105,526,596
Cements, limes, plasters, etc.	36,849,943	45,607,436
Total	$199,451,120	$219,094,500

Of the three sub-groups of materials quoted in the above table, the third—the cementing materials—is at present of greatest interest, though it is still surpassed in value by the other two. The following table gives in more detail the value of the production in the United States, for the years 1900-1903 inclusive, of the six classes contained in the general group of cementing materials.

Value of Cementing Materials Produced in the United States, 1900-1903.

	1900	1901.	1902.	1903.
Plaster of Paris, wall plaster, etc.	$1,500,270	$1,325,517	$1,889,190	$3,550,390
Lime	6,970,062	8,597,030	9,573,011	10,105,190
Magnesia and magnesite	19,333	43,057	21,362	20,515
Natural cement	3,728,848	3,056,278	4,076,630	3,675,520
Portland cement	9,280,525	12,532,360	20,864,078	27,713,319
Slag cement	274,208	198,151	425,672	542,502
Total, cementing materials.	$21,773,246	$25,752,393	$36,849,943	$45,607,436

It will be seen that the value of the entire group has more than doubled in these four years. Examination of the figures for each subgroup will show that this increase was by no means equally dis-

tributed. The production of Portland cement almost tripled in value from 1900 to 1903; the values of the plaster and slag-cement production about doubled; while lime increased only 50 per cent, and magnesia and the natural cements were practically stationary.

The increase in the value of the American Portland cement production is a feature to which particular attention should be drawn. The manufacture of this product was commenced in the country about 1875, but in 1889 its annual production amounted to only $500,000. Since that date, however, the advance has been marvellous. The remarkable rate of increase is best shown in Figure 3, where the Portland cement production of the United States for the years 1888-1903 is plotted side by side with two much more widely advertised industries. Every one knows of the gold discoveries of Cripple Creek and in Alaska, but a glance at this diagram will show how unimportant were these rich finds of the precious metal in comparison with the quiet growth of a more important industry.

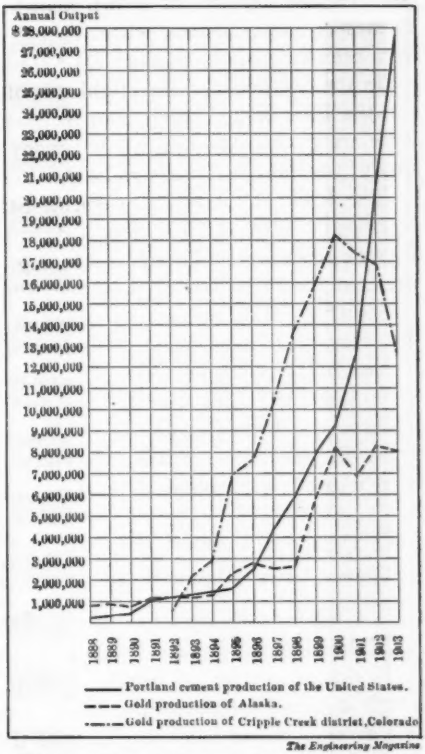
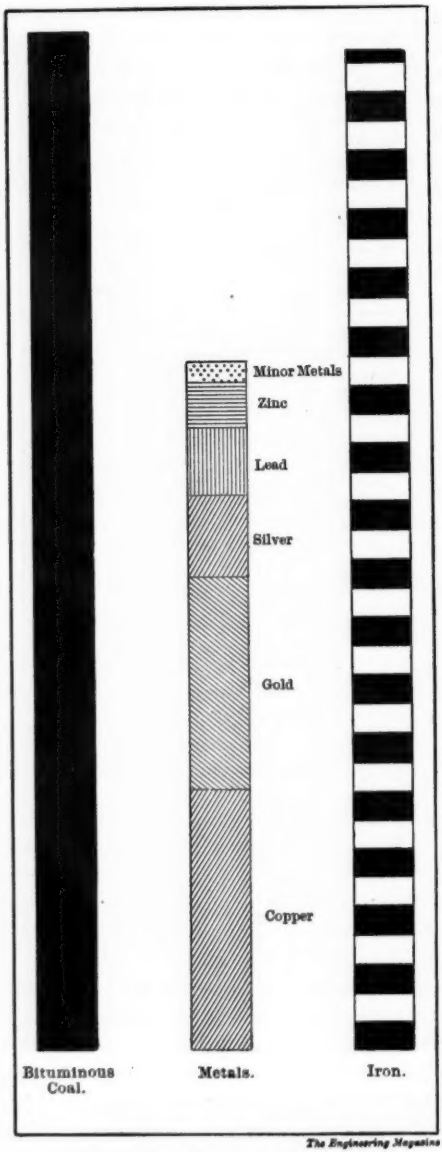


FIG. 3. GROWTH OF THE AMERICAN CEMENT INDUSTRY.

It will be seen that the three great groups which have been discussed—the fuels, iron, and the structural materials—account for over 80 per cent of the total mineral production of the United States. The remaining 20 per cent is made up by a very heterogeneous collection of products, including some—such as gold, silver and copper—which are often considered to be of great importance.

The fact that these three groups make up four-fifths of the mineral



COMPARATIVE PRODUCTION IN 1903.

output is, of itself, quite striking. But the situation becomes still more interesting when the *indirect* value of the products is taken into consideration, for iron, the fuels, and the structural materials are all of low unit value, and their output must be of immense tonnage in order to place them ahead of more costly products. The aspect from this point of view is brought out in the accompanying figure, showing the comparative production of coal, iron, and the metals in 1903. This immense tonnage implies, in turn, the employment of much capital and labor in handling and transporting such products. One thousand dollars' worth of pig iron, for example, would be perhaps seventy tons; one thousand dollars' worth of gold would be little over four pounds. It can readily be seen that the production of one thousand dollars' worth of iron will give indirect employment to much more capital and labor than will the production of the same value of gold.

A STUDY OF THE CORROSION OF CONDENSER TUBES.

By A. Humboldt Sexton.

Professor Humboldt Sexton's opportunities for the thorough and practical examination of his subject have been unusual, and his conclusions will impress his readers as being very well supported. They appear to point the way to the prevention of an annoying and serious trouble which has perplexed marine engineers and other steam users, and will be proportionately welcome to those who have suffered from the phenomena discussed. Professor Sexton, on his part, will welcome discussion of his results, and co-operation in the further study of the subject by way of the contribution either of experience with condenser-tube corrosion or of materials showing its effects.—THE EDITORS.

THE corrosion of condenser tubes is one of the difficulties which the marine engineer has constantly before his mind, for not only do the failures thus caused give him endless trouble, and put him to considerable expense, but the corrosion takes place in so many ways and seems to be so erratic that it is almost impossible to guard against it, and in the minds of many engineers there is a feeling of uncertainty and insecurity which is far from pleasant.

I have had the opportunity of investigating certain cases of bad corrosion of condenser tubes, and have devoted a considerable amount of time to the experimental study of the subject; this paper is therefore submitted as a summary of the present position of our knowledge with reference to this subject, and at the same time as a contribution to its further study. It is not hoped to answer definitely all the questions that may be asked, or to solve all the difficulties that arise in practice, but perhaps to make clear the principles on which corrosion depends, and to record results which may serve as a basis of future work.

At the outset it may be advisable to say a word or two as to the phenomena of corrosion as seen in condenser tubes, and all the points mentioned will be referred to later. It is assumed that the tubes are of brass, containing 70 per cent of copper and 30 per cent of zinc, which is the composition most generally used. When the tubes are removed from a condenser as being worn out, or at any rate, as being unfit for further use, probably on account of the failure of some of them, they will usually be in one of three conditions:—

(1) The tubes may be worn down nearly uniformly, the thickness of the metal being often considerably reduced, though of course it will be thinner in some places than in others. On making a section the remaining portion of the tube appears to be of brass quite unchanged.

(2) The tube may be considerably reduced in thickness, and as before to some extent uniformly, but there may be pitting here and there, and the inner surface of the tube seems to have become converted into copper—that is, it is dezincified—and this change in some cases may have gone to a very considerable depth.

(3) The tube may have worn down very irregularly, dezincification being well marked, often in patches, and sometimes extending at various places quite through the metal, giving the appearance of small plugs of copper, which may be either firmly adherent or quite loose; probably there will also be holes corroded through the tube—few or many, as the case may be. These plugs of copper and the holes will usually lie almost in one line, this line being at or near the bottom of the tube, when it is in position in the condenser.

Tubes in the first condition will usually have stood well, and may have been in use many years, those in the second condition may have lasted fairly well, but those in the third will usually have had a short life. The tubes which give trouble to the engineer are often found to be in the third condition.

In addition, there may be corrosion or dezincification to a smaller extent from the outside or steam side of the tube, but this is usually due to causes different from those which cause the corrosion from the inside.

The tubes also frequently contain more or less deposit, but this varies so much in appearance that it is impossible to give a general description. Sometimes the tubes are nearly clean inside, and almost free from deposit; sometimes there is a thin skin of black material; whilst in other cases, and often where the tubes have stood badly, there is a heavy deposit, black or brown in colour and containing a large amount of ferric hydrate. There are also usually patches, and sometimes a layer of a green deposit which is often very irregularly distributed, and sometimes clusters of white crystalline needles, or nodules of white crystals. Very frequently dezincification is very marked beneath the green deposit. The meaning of these appearances will be discussed later.

The corrosion with which we are concerned takes place in ocean-going steamships, in which the tubes are kept filled with sea water

and so serve to condense the steam which surrounds them. The evidence is quite conclusive that sea water is the corroding agent, but its action may be accelerated or retarded by the presence of other materials and by the conditions under which the tube is placed.

Both copper and zinc are readily acted on by sea water under ordinary conditions and even at ordinary temperatures, and much more readily at higher temperatures. Brass, which is an alloy of copper and zinc, often with the addition of a small quantity of tin, is also acted on; but if of suitable composition, much less so than either of its constituents alone.

Sea water contains a considerable quantity of salts in solution, the one in largest quantity being sodium chloride, or common salt; it also contains, in solution, a considerable quantity of oxygen and of carbon dioxide. There is no doubt but that the oxygen in solution is largely responsible for the corrosion, and that the carbon dioxide plays some part in it; but the presence of this latter is by no means essential, as corrosion will go on, though at a reduced rate, when carbon dioxide has been completely removed.

The formation of the deposit found in corroded brass tubes, in so far as it is derived from the corrosion of the tube itself, is due to the combined action of the water, salt, oxygen and usually carbon dioxide, as is evident from its composition. In one case, the deposit from a corroded tube was found to have the composition:—

Copper oxide	30.85
Copper chloride	3.20
Zinc oxide	30.80
Iron oxide	11.40
Insoluble matter	3.08
Organic matter, carbon dioxide, water	20.67
	100.00

These figures are of importance, for they show that in this case at least the deposit is basic chloride and carbonate of copper and zinc. It contains copper and zinc in nearly equal quantities, though in the tube the metals were present in the ratio 7:3, so that it is quite obvious, as indeed will be demonstrated later, that the zinc is more readily removed from the brass than the copper. It should also be noted that there is a considerable amount of oxide of iron (as hydrate), insoluble matter, and organic matter, which could not have been derived from the tube itself, but must have been introduced from the outside. This is the case in every sample of deposit from badly corroded condenser tubes which I have examined.

A sample of the deposit formed by the action of clean sea water on copper was found to contain:—

Copper carbonate	29.77
Copper chloride	8.39
Copper oxide	59.38
Water	2.46
	100.00

A large number of experiments have been made on the action of sea water on various metals, but more particularly on brass, with special reference to this question of corrosion. Weighed pieces of metal have been exposed to the action of sea water, in some cases for many months, the water being frequently changed so that the action might not be interfered with by the removal of oxygen and carbon dioxide, which must have happened had the same quantity of sea water been used the whole time. Most of the experiments were made at the ordinary atmospheric temperature, but in some cases the tubes and samples were for some weeks heated to about 80°C. during the day and allowed to cool at night. It would occupy too much space and would hardly be of interest to quote results of the experiments in detail, but a summary of the results obtained with brass may be of interest. Taking first of all a brass containing 70 per cent of copper and 30 per cent of zinc, which is the usual composition of the brass used for boiler and condenser tubes:—

The action of sea water was very marked in every case, and as might have been expected was much more rapid when the water was heated. A green deposit was formed, exactly resembling that obtained from corroded condenser tubes. Sometimes this adhered to the metal, but at other times was quite loose. In some cases growths of white crystals of a zinc salt were noticed, exactly similar to those already mentioned as occurring in corroded condenser tubes. The zinc was always dissolved much more rapidly than the copper, but the proportion varies with circumstances. As a rule about five or six times as much zinc was dissolved as copper, whilst in the brass of course, the ratio was 3:7. The action is more rapid at first; the green deposit which forms on the surface of the metal, especially if it be adherent, seems to some extent to protect it from further action.

It will be noticed that if the metals were attacked in this ratio in the tube from which was taken the deposit, the analysis of which has been given, a considerable quantity of zinc must have been removed in solution or in suspension.

When the brass contains 66 per cent or less of copper, the action

is very different; the amount of copper removed is small and the deposit is nearly white, consisting almost entirely of zinc salts. In a 66/34 brass tube the ratio of zinc to copper dissolved was 146:1 in one case and 214:1 in another, whilst with 50/50 brass, only a minute trace of copper was removed.

The actions by which a brass tube may be corroded are usually divided into three kinds:—

1. General corrosion, in which the copper and zinc are removed practically together (i. e., in the ratio in which they exist in the alloy) by chemical or electric action, the tube thus diminishing in thickness but otherwise being unchanged.

2. Dezincification, in which the zinc is dissolved more rapidly than the copper and thus a surface layer (or local spots of a material very rich in copper) is left.

3. Erosion, in which the metal is worn away by the mechanical attrition of the water.

Corrosion of brass tubes always primarily takes the form of dezincification—except, of course, in the case of erosion—the sea water attacking the zinc more readily than the copper, the copper being left in a spongy form, which is very easily worn away. Whenever the copper and zinc seem to be removed together—i. e., when general corrosion takes place—it is always because the spongy copper left by the dezincification has been removed by the mechanical action of the water aided by solid matter which may be in suspension, and this is why tubes which are worn away very uniformly show little sign of dezincification.

The question, however, remains to be answered:—"Why is the action so much more rapid in some cases than in others? Why is it that whilst in some cases condenser tubes will last ten years or more, in others they fail in a few months, or occasionally even a few weeks?"

Obviously the fault—if fault there be—or at any rate the reason must be in one of two places. It must either be due to something in the nature of the tubes themselves, or to the conditions under which they have been worked. There is no alternative unless we assume some occult cause to explain the apparently erratic behaviour. Each view has its advocates, the former being favoured as a rule by engineers who use the tubes, but who are not familiar with the processes of manufacture, whilst the latter is the view taken by the manufacturer.

I hold no brief for either side; I have investigated the matter as fully as I have been able, both in the laboratory and by practical ex-

aminations of cases of failure, and I am quite familiar with the methods by which the tubes are made and the processes through which they pass before reaching the engineer who will use them.

The tubes are, as already remarked, usually made of brass containing 70 per cent of copper and 30 per cent of zinc, this being the mixture almost invariably specified. It is found to be as durable as any other, there being no advantage whatever to be gained by increasing the percentage of copper. A slight variation up or down has no deleterious influence, and of course an increase in the quantity of copper is not likely to be injurious. Any careless work on the part of the founder is likely to lead to a greater loss of zinc and therefore, to a slightly higher percentage of copper. Many specifications are quite unnecessarily rigorous in the variations in the ratio of the two metals which they make allowable.

The composition of the tubes is always uniform. The composition at the two ends is always the same, and there are no spots richer or poorer in copper. This has been proved by many analyses; but quite apart from that, the conditions under which the tubes are made render such variation well nigh impossible, and the idea that there may be spots or patches in a tube differing in composition from the rest, which might set up electrolytic action and thus give rise to local corrosion, whilst believed by many engineers, is not in harmony with facts. The coppery plugs or spots already mentioned have been thought by some engineers to be due to fragments of unalloyed copper left in the mixture. This suggests an impossibility; for the spots are always round, and a fragment of copper if left unalloyed in the casting—which is, however, impossible—would be drawn out into a minute thread in the process of drawing, through which the tube goes. These spots or plugs are of quite common occurrence in badly corroded tubes, though they are very often overlooked. The inside of the tube when taken from the condenser is usually covered with deposit; the outside is covered with grease; and it is not until these are cleaned away that the spots can be seen. The engineer as a rule is not concerned to make a minute examination of the failed tubes; he is anxious to get them away and to get new ones in their place, and hence unless there is some special question likely to arise, the tubes will not be examined and the spots will not be detected. These spots of copper are certainly due to dezincification, as also is the layer of copper sometimes found inside the tube, and the copper almost always retains a certain amount of zinc. In one case a fragment of a coppery patch from a corroded tube contained 3.7 per

cent of zinc, showing that most of the zinc from the original brass had been dissolved away at that spot, and a specimen of dezincified layer from inside another tube contained 3.84 per cent. of zinc.

It is very doubtful whether the use of specially pure metals is any great advantage, though it is no disadvantage, and it is wisest to err—if at all—on the safe side; but the use of specially pure and, therefore, costly metals seems to entail increased cost without any cor-

FIG. I. MICROSECTION OF BRASS CONDENSER TUBE, SHOWING COARSE CRYSTALLIZATION.

Magnified about fifty diameters.

responding advantage. Nothing in the chemical composition of the brass, if it be approximately 70 and 30, will account for the variations in the durability of the tubes. Indeed, it not infrequently happens that with tubes as far as can be detected in all respects identical as to composition and make, one set will wear well, whilst another will corrode with extreme rapidity.

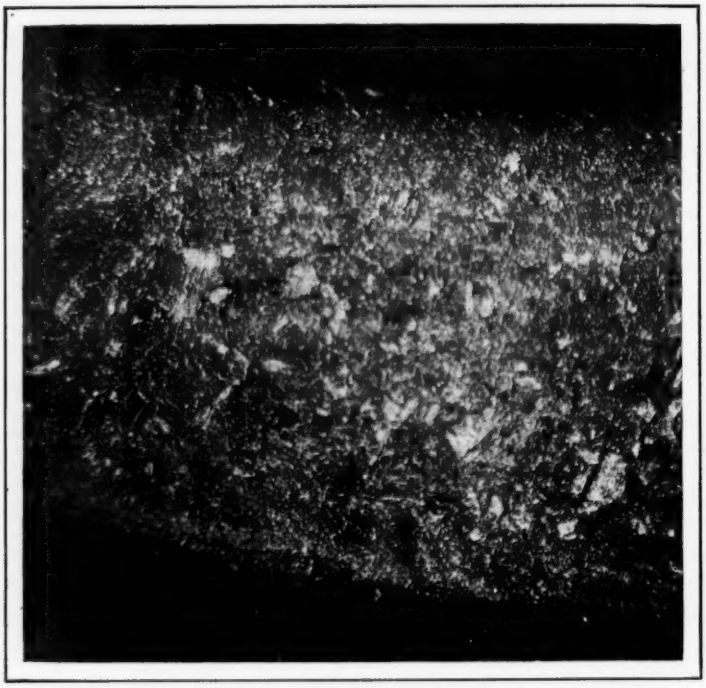


FIG. 2. MICROSECTION OF BRASS CONDENSER TUBE, SHOWING MEDIUM AND RATHER IRREGULAR CRYSTALLIZATION.

Magnified about fifty diameters.

The mechanical structure of the metal has sometimes been held to be responsible for corrosion. Brass containing 70 per cent copper and 30 per cent zinc is a homogeneous alloy. On cooling, it crystallises as a whole and does not separate into two constituents as the poorer brasses do. It behaves in this respect as if it were a chemical compound, but that it is not a true compound is shown by the fact that the elements are not present in simple atomic ratios, that the composition may be varied within wide limits upwards, and to a small extent downwards, without altering the structure, and by many of its chemical reactions. It crystallises as a whole and forms a homogeneous crystalline mass. In the casting the crystals are very large and distinct, but they are broken up during the drawing, and are re-formed when the metal is annealed. The actual size of the crystals

in condenser tubes varies very much, the difference being probably due to variations in the time and temperature of annealing. Figures 1, 2, and 3 are microsections of brass condenser tubes magnified about fifty diameters. It will be seen that the size of the crystals is very different in the three cases. This difference in the size of the crystals may have a profound influence on the physical properties of the metal, but has no influence whatever on its resistance to corrosion.

It has been suggested that the crystals being differently oriented might set up galvanic action, so that the lines of junction of the crystals might become centres of corrosion. There is no evidence whatever in support of this idea; and even if it were true, it would not account for the formation of pits and corrosion patches a considerable distance apart. I have found that dezincification bears no

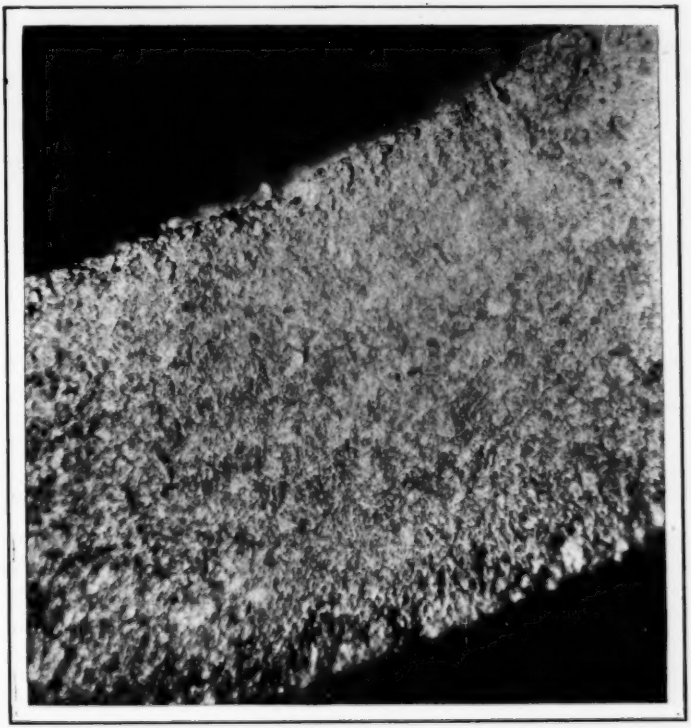


FIG. 3. MICROSECTION OF FINELY CRYSTALLIZED BRASS CONDENSER TUBE. FIFTY DIAMETERS.

relation whatever to crystal structure, the line of action as often passing right across a crystal as round its margin.

It has been contended also that the larger the crystals the more rapid will be the corrosion. This, however, is certainly not the case. I have found that the size of the crystals has no influence whatever on the corrosion of the metal. A very large number of corroded tubes have been examined and it has been found that good and bad tubes —the quality being measured by the amount of corrosion that has taken place—are impartially distributed between those with a coarse, medium, and fine structure.

Among methods that have been suggested for increasing the durability of condenser tubes may be mentioned the addition of a small quantity of tin to the alloy. The British Admiralty, for instance, uses an alloy which contains 70 per cent of copper, 29 per cent of zinc, and 1 per cent of tin; but it is very uncertain whether this is any material advantage. The coating of the tubes with tin has also been tried, but the protective action, if any, is very small. I am convinced that for this particular purpose nothing is better than 70/30 brass.

I feel quite certain that the cause of variation in the durability of condenser tubes is not to be found in the chemical composition or physical structure of the metal, nor in any variation in the process of manufacture, nor in anything connected with the tubes; indeed, the tube-maker, while keeping to the specified composition and passing the tubes through the usual tests for soundness, could not, if he tried, turn out a tube specially liable to corrosion. This is, of course, not the usual opinion of engineers. They say: "Here are two steamers working under exactly similar conditions, and whilst in one the tubes have stood well, in the other they have corroded very rapidly; therefore, the reason must be in the quality of the tubes." This dilemma may, however, be put in another way. Here are two steamers fitted with exactly similar tubes, selected haphazard out of one large parcel; in the one steamer the tubes have stood well, whilst in the other they corroded rapidly, therefore there must be a difference in the condition of working. The latter is certainly the correct view, for there are so many possible variations in the conditions of working that it is impossible to decide when these are uniform. Two steamers moored at the same berth on a river may be under very different conditions, and so in many other ways there may be differences of condition which, together with differences in the way in which the condenser is treated by the engineers in charge, may account for the differences in the corrosion of the tubes.

The solvent action of sea water will account for the slow and steady dezincification which will ultimately wear away the tube; but this will take years, and something more is necessary to explain the irregular corrosion which is so destructive. The corrosion into holes in particular spots seems to indicate some local cause, and at once suggests electrolytic action, the tube itself being the anode; but if this is the case, the difficult thing is to find what can be cathode. It must obviously be some substance strongly electro-negative to the brass.

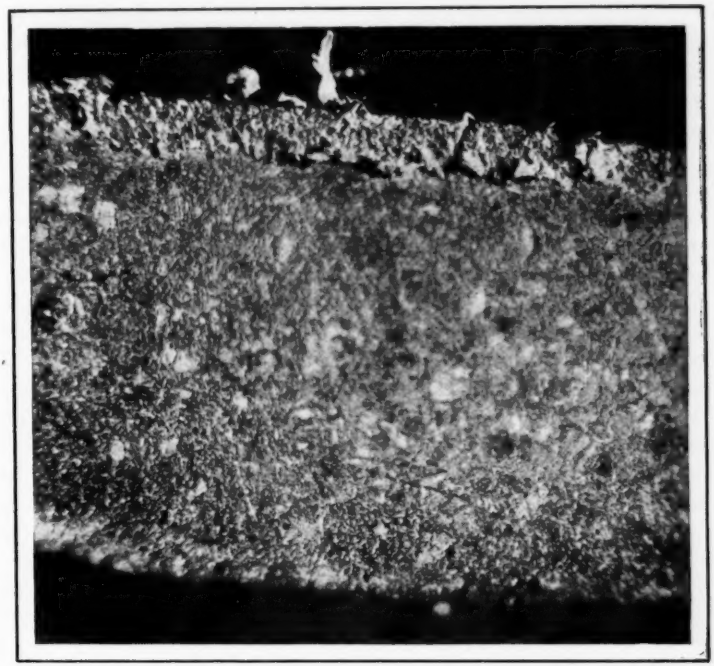


FIG. 4. CONDENSER TUBE, SHOWING LAYER OF DEZINCIFICATION. FIFTY DIAMETERS.

Many experiments have been made as to the influence of the contact of various substances with 70/30 brass—pieces of condenser tubes being used—immersed in salt water, and though the results obtained are not new, they tend to throw some light on the subject under discussion.

Malleable iron and zinc in contact with the brass, as might be expected, completely protect it from corrosion, being strongly electro-

positive to it; on the other hand, when a fragment of graphite was placed on the metal, a well marked spot of dezincification (i. e. copper spot) was formed beneath it. The spot was, of course, only superficial, the length of time the experiment was continued not being sufficient to allow the action to go on to any depth. With a piece of coke an exactly similar result was obtained. In both cases the action was more marked when the water was heated. A layer of blacking, which is nearly pure carbon, increased the action of sea water, and also increased the ratio of zinc to copper dissolved. Similar results were obtained with other substances. The green oxychloride of copper seems to protect the copper, and thus to increase the ratio of the zinc dissolved. Ferric hydrate is stated by Professor Tilden to cause rapid corrosion. With a fragment of iron scale, dezincification under the scale was well marked, but copper scale has no such action.

Foul river water has been accused of causing rapid corrosion, and it may be admitted at once that there are many cases of rapid corrosion in the case of steamers plying alternately on such waters and on the sea—perhaps more than on steamers plying only on the deep sea; on the other hand, in many such steamers the tubes last quite the normal time. It will, of course, be admitted that acid waters will be likely to increase corrosion considerably, though 1 per cent sulphuric acid has little more action than sea water; in any case, the action of an acid water would be expected to be nearly uniform, and whilst it might accelerate corrosion, would hardly be likely to cause pitting. It is only in very exceptional circumstances, as for instance when acid refuse is discharged into a river, that the water will be sensibly acid.

Brass tubes exposed for four months to Clyde water—and the Clyde is not regarded as the purest of rivers—taken from the Broomielaw, did not lose seriously in weight, but only became tarnished by the formation of a dark layer, apparently of copper sulphide. Some samples of brass tube were moistened with ammonium sulphide so as to produce dark stains of copper sulphide, and were then put into sea water. The action was at once very marked, the ratio of zinc to copper dissolved being increased to 16:1 per cent in one case and 12:1 per cent in another. It would seem, therefore, that a river water containing sulphides might cause a deposit of sulphide which on the tubes being filled again with sea water, would set up corrosion and this being repeated day after day, vigorous corrosion might result.

Other suggestions have been made, as for instance, that the cor-

rosion may be due to electric currents, from the electric lighting or other electric plant on board ship, especially where the single-wire system is used. This may be an occasional cause of corrosion, but I do not think it is at all frequent. It is difficult to see how stray currents can find their way into the condenser, so as to cause electrolytic action. In a paper read before the institution of naval architects on April 3, 1903, Mr. A. W. Stewart describes the corrosion of copper bilge suction pipes on certain steamers of the Russian volunteer fleet, and he comes to the conclusion that in this case electric currents had nothing to do with the corrosion. Corrosion does not seem to be more common in steamers with electric fittings than others, nor does it seem to have increased since the use of electricity became common.

In the above mentioned case, Mr. Stewart ascribes corrosion to the presence of oils and grease. But it is obvious that this is not likely to be the case inside condenser tubes, where grease or oil could not ordinarily find its way. Corrosion on the outside of condenser tubes, which is usually on a small scale, is no doubt often produced by oil or grease carried over by the steam.

I have come to the conclusion that rapid and irregular corrosion, as distinguished from that due to the normal action of sea water, is almost invariably due to electrolytic action set up by the contact of particles of substances electro-negative to the brass, probably in most cases carbon.

Where can these particles come from? Frequently they may come from outside, especially if the water be drawn from such a position that cinders thrown overboard may be drawn in with it; and cinders have actually been found in corroded condenser tubes. In some cases particles may be derived from the cast-iron doors of the condenser itself, if these are not well protected. A fragment of cast iron would be rapidly oxidized, and for a time would act as a protective agent, but as soon as the iron was dissolved the particles of the residual spongy mass, consisting mostly of graphite, would be electro-negative to the brass and would cause rapid corrosion. If the iron of the door rusted, the graphitic mass would be easily detached, and might be carried into the tube. As already remarked, the corrosion spots usually lie in a line along the bottom of the tube, this indicating that they have been caused by something which settles there. It is also noteworthy that the deposit in corroded tubes nearly always contains a considerable quantity of oxide of iron, which must have been derived from some external source. When a steamer plies on a foul

river, the conditions are much more likely to lead to corrosion than on the open sea. On such a river as the Clyde, cinders and fragments of charcoal frequently float on the surface, and may readily be drawn into the condenser. The water may contain sulphides, as evidenced by the very strong odour of sulphuretted hydrogen that may often be detected, and thus patches of sulphide may be formed which may subsequently set up action. Sticky organic and oily matter may frequently be present, and these, though they may have no direct action, may cause the adherence of particles which may in their turn lead to corrosion, especially when coming in contact with sea water. Indeed, the composition of foul river water is so complex and variable that it is difficult to say what action may not take place. The conditions also of such a river vary much with the seasons and other circumstances. In time of drought, when the water is low, it will be more strongly charged with impurities than in times of rain when there is abundance of water. The discharge of acids and other impurities from works is not continuous, but takes place at intervals only, and there may be variations even from hour to hour; and even if the conditions are the same, the state of the tubes as to deposit, and other conditions, may much modify the action.

As to the cure for irregular corrosion, there is none—at any rate after it has made progress; but like many diseases, if it cannot be cured, it can be prevented; and I am strongly of opinion that it is always preventable.

1. The corrosion from the presence of solid particles can take place only if such particles are allowed to rest in the tubes. If the current be strong, therefore, corrosion is little likely to take place, while if it be sluggish, corrosion is very probable. Should a tube become partially stopped for any reason, that tube is specially liable to corrosion. Sluggish circulation is a very common cause of corrosion.

2. The tubes must be frequently cleaned, so that any deposit which is forming may be removed. This is of special importance in steamers running in foul rivers which may readily pick up substances which may cause the adhesion of objectionable material.

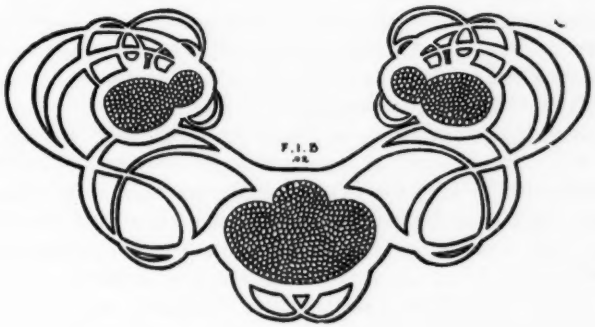
As has been pointed out, tubes that have corroded badly are almost always characterized by the presence of a heavy deposit.

3. The tubes should never be left full of water when the steamer is at rest, but should be run dry and perfectly washed out with clean water, as soon as the day's work is done. This, too, is of special importance in steamers running on foul rivers where objectionable matter may be drawn in, which, during the period of rest, will settle to

the bottom of the tube and form a lodgment from which it will not be displaced when work is resumed, and so corrosion may be set up, and once started it will go on rapidly under the deposit formed.

In conclusion, I am quite convinced that if the condensers be well designed and these precautions be taken, very little will be heard of unduly rapid corrosion, but that unless such precautions are taken the tubes will always be liable to erratic and rapid decay, and the conditions being entirely beyond any power of calculation, no estimate or guarantee can be given as to the probable life of a tube.

Some of the experiments cited are only tentative, and perhaps some of the conclusions may not be fully proved; but I feel quite sure that on the whole they are sound and in the right direction. I will be much obliged if engineers and others who come across cases of corrosion which either bear out or tell against these conclusions will communicate with me and send samples of the corroded tube, deposits, and anything else that may help to complete the investigation of the causes of the corrosion of condenser tubes and other underwater fittings on board ship.



STEAM BOILERS OF THE PAST AND THE PRESENT.

By Egbert Pomeroy Watson.

Mr. Watson's discussion of his topic has the vitality which springs from his lifelong association with the making and the working of steam boilers. He has been among those who made the experience which has found formulated expression in modern practice, and in his article the reader will find himself following the successive steps of development in the art, with a clear understanding of the environment and of the spirit of the earlier steam engineers and constructors. Beyond this, Mr. Watson gives a very lucid explanation of the difficulties which confront the steam user and the boiler tender, and of the effective remedies.—THE EDITORS.

COMPARISONS between the splendid steam generators of the present and the same apparatus built by our grandfathers would be unfair, unless the conditions under which both were built are taken into account. We have now a material—steel—which is ideal for the purpose and will stand an amount of fatigue under stress and distortion that is astonishing, commanding the admiration of men who are not usually enthusiastic about anything. Its endurance under flanging into any departure from a flat sheet is remarkable, there being, apparently, no limit to the punishment ti will stand without "crazing" or showing weakness of any kind. Modern open-hearth steel can be fashioned into all sorts of shapes and retain its elasticity and homogeneity throughout.

Modern high pressures were impossible in the early days of boiler making, for want of material; but we think no more now of constructing generators to carry 250 to 300 pounds per square inch, than we did fifty years ago of expecting them to stand less than one-fifth of that pressure, not feeling at all certain even then that some flaws did not exist in the sheets which could not be seen externally.

It is not asserted that good material for making steam boilers did not exist half a century ago, but that it was not always used for that purpose is undeniable. Tests of American plates made prior to 1860 show a tensile strength of 66,000 pounds, or more than the average boiler steel of today; this was charcoal iron, of course, and was sometimes bloomed and in other cases puddled; but even this was not uniform in quality, depending (as it did) for accuracy of observation

as to the critical point by the workman in charge. The searching analyses of the present day were not generally practised by the manufacturers of 1850; they were not unknown, however, for I find by reference to a treatise of the period named that the same elements which now are expurgated, so to speak, are adverted to and called "impurities." Sulphur, phosphorus, silica, arsenic, etc., were known to work mischief.

In half a century great progress has been made, not only in better processes but in material as well. Necessarily much had to be learned in this direction; everything was lacking. Precedents, procedure, tools, and the "know how to do it," which last is a great element in succcess. We might with as much propriety deride the efforts of a child learning to walk as to compare the steam generators of half a century ago with those we now build. Success and failure are alike founded upon the mistakes of others.

By trial and error, those inexorable teachers, we have at last arrived at a point where we can predict with some approach to certainty what the action of certain forms or types of boilers will be, always excepting variations and departures from standard types with the same details differently disposed. Such a modification is supposed to constitute a new boiler, when the facts are that the only difference between it and well-known forms is that the arrangement of the heating and water surfaces, or their disposition with relation to one another, has been altered; this makes a vast difference in the working and general behavior of the apparatus as a whole, warranting the assertion that nothing can be predicated of the action of a new boiler. One of the most successful boilers in the market today has been built for years as a stationary boiler, but the proprietors introduced it for marine purposes and for a long time met with every kind of disappointment in regard to its performance; nevertheless by constant experimenting at an enormous expense they were able to locate the causes of erratic behavior, and from a failure in its new sphere to remodel it into a generator of high efficiency. Most new boilers have a certain facility of steaming and an apparent accessibility for cleaning and repair, but it is only after months of actual service under varying conditions that they reveal their weaknesses; after the heating surfaces have become foul with scale and soot, with innate depravity, perhaps, it shows an obstinate determination to fill up in the most inaccessible spots. Expansion and contraction were the two forces which gave our forefathers the most trouble, and they are by no means overcome yet. The parts give and they take, "but one event

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happeneth to them all"—complete disruption of the connected portions, eventually, unless the result is forestalled and prevented by compensations provided by the designer.

A feature of marked value in certain types of modern steam boilers is the rapidity with which they generate steam, vying in this direction with steam fire engines. Considering the water content of both types, the marine boiler of the present is even superior, pressure for pressure. It is easily possible to generate 250 pounds of steam from cold water in a 1,000-horse-power marine boiler in ten minutes without injury to any part; and these are not torpedo-boat boilers with one inch tubes, but battle-ship boilers holding, in many cases, more than fifty tons of water; compare this with the fire-engine boiler, holding a barrel or two of water only, and the marine boiler does not suffer by the contrast. Not all marine boilers are capable of steaming with the facility mentioned; there are still a large number in use which require hours instead of minutes to get a working pressure; the fact remains, however, that, by and large, the sluggishness of steaming peculiar to the boilers of half a century ago has been removed to some extent, and wholly in the special types mentioned.

Circulation in steam boilers is either natural or artificial; in the first instance the water is carried over the heating surfaces in regular sequences; in the latter it is arbitrarily forced in contact with them by pumps or their equivalent. In some types of boiler there is no large body of water present—the flash-boiler, for example—and there is no circulation except that given by the incoming jet; this is not a true circulation for the reason that the water does not come in contact with all of the hot metal. Where the jet strikes first the water is immediately vaporized in whole or part; that which is not falls to the bottom; if the heating surfaces are in coils the water never gets to the bottom of it as water, but in the form of steam, and the heat which is in that portion of the coil is lost or dissipated in reheating the steam—desiccating it, as one may say. True circulation in a steam boiler is that which, under the influence of heat causes the water to traverse the line of least resistance, covering all the hot surfaces as it goes, moving in a direct line for the drum, or whatever reservoir is provided for the steam. Where this kind of circulation exists the boiler is a quick steamer, and the products of combustion go into the funnel at very low temperatures—so low, in fact, that they cannot evaporate water, no matter how much heating surface there is yet to be traversed. It is for this reason that superheaters placed in uptakes intended to high dry steam fail to do so—the spent gases are

too cold. The steam made by boilers with poor circulation is inferior in quality in that it holds more or less water in suspension. This is a fault of the design, for watery steam is adulterated steam, which must be strained before it can be used economically. The dispersion of the water is accomplished by apparatus of one kind or another which is called a separator, and it performs a double office, to wit: separating the steam and water, and separating the steam user from his money beyond recourse. No part of the water heated to the boiling point and then thrown away through the separator is ever recovered. It is a total loss, of considerable amount where many separators are in use. Two per cent. is a very moderate amount of moisture held in suspension in steam; the average in very faulty boilers is much more; it is easy to estimate what amount of water is turned into steam and then thrown away in large steam plants by boilers which have poor circulation and resort to separators as a remedy for it.

A dry pipe is a much better remedy for a foaming boiler than a separator—when the dry pipe is properly made. In most of them the holes are too large. I have built a good many boilers where the water line was within six inches of the steam outlet—very rapid evaporators, too—but I never had a drop of water drawn into the steam pipe, the reason being that the steam-holes in the pipe were made with a No. 60 twist drill. These boilers ran perfectly for a long time with very bad water, but they never scaled over or stopped up. Most dry pipes, or very many that I have seen, are drilled with 3-16-inch holes. This is no bar to the passage of water and steam mingled, but dry pipes have been condemned as useless because they were not properly made. The losses by wet steam do not, of course, end with loss of heat, but this is another branch of steam engineering which need not be considered in this connection.

Probably no apparatus used in the arts suffers so much from ignorance and abuse by carelessness upon the part of both owner and engineer as a steam boiler. Neglect is the rule rather than the exception. There are no working parts about boilers; they never protest audibly, as engines do by pounding or other external evidence of internal distress, but they waste away by slow degrees until they are no longer safe to use. Parsimony and ignorance are the causes of this—the first on the part of the owner and the second on the part of those in charge. It would seem as though any one fit to be about a boiler could not help remarking that the water which is used for making steam carries more or less dirt with it which should

be removed frequently, but, aside from this, the mineral matter held in suspension in the water is the most serious point to be considered. The average man is not supposed to know this; he feels that scale, even when he knows that there is such a thing, is a natural consequence and unavoidable—an act of God, as it might be called, for which he is not responsible and against which man strives in vain. If it were possible to reach all inexperienced persons in charge of boilers and point out to them by word of mouth that by care at the proper time they can in a great degree prevent scale from forming, there would be a change for the better and boilers would last longer. Ask them to consider the fact that water holds from 40 to 60 grains of solids to the gallon (not inclusive of free dirt) and that a 60-horse-power boiler should evaporate at least 1,500 pounds of water per hour, 15,000 pounds in a workday of ten hours; that in one pound avoirdupois weight, sixteen ounces to the pound, there are 7,000 grains—and then consider how long it would take to fill a boiler up chock-a-block with refuse unless it is removed in some way! Examples like these would be understood by even unlettered men, but the difficulty resides in the fact that such persons seldom read and cannot be reached. A remedy for loss and injury to boilers lies in the expectation that steam users will read and see for themselves that their plant is properly cared for.

Aside from the damage incurred by scale, which is simply matter in the wrong place, there are a large number of evils boilers are heir to, which unless prevented tend to shorten their lives and are a source of expense to the owners of them. These defects are here enumerated:—deposits of free dirt; incrustation and scale; internal grooving; external grooving; internal and external corrosion; broken and loose braces and stays-bolts included; bad settings; distorted furnaces (crown sheets down); cracked plates; burned plates; blistered plates (baggings in shells over the fire of return tubular boilers); bad riveting; defective heads; serious leakage around tube ends; defective blow-cocks; shortness of water; overloaded safety valves; bad safety valves; incorrect steam gauges, fast or slow; besides many other minor matters that need not be classified.

Of these causes of deterioration, by far the most numerous are those arising from the presence of scale and its twin sister, incrustation; but broken braces can give an engineer a very bad quarter of an hour. A steamer plying on the Great Lakes many years ago carried very high steam for those days—50 pounds per square inch on a very large and light shell. The engineer on watch was down in the

fireroom looking around when a loud bang came from one of the boilers. Instantly divining the cause he looked questioningly at the head water-tender, who replied: "Be jabers, I hope that ain't next-door neighbor to the one that let go on the other watch."

That startled the engineer, for he had not been told of the other broken brace; he at once stopped the blowers, opened the doors, shut the stop-valve between boilers, and put on the feed pumps as rapidly as they could go so as to reduce pressure. The deck department was notified that it would be necessary to stop, and they hauled to one side of the channel and waited for the coming up of another boat in the same line passed a few miles back. The passengers (there were 1,000 on board) and mails were transferred, and the boat returned with the injured boiler out of business. Upon examination the next day it was found that three braces had given away at or near each other, two letting go simultaneously, apparently, and that the precautions taken against a disaster (which would have been terrible if it had occurred) were none too soon. This was merely an episode within the everyday duty of an engineer, and carries its own warning.

Within the last decade a new peril to steam boilers has been detected, giving engineers great anxiety, and for a while, baffling all investigation as to its cause; this is oil finding its way into boilers, and the results of it. I have said the last decade, but time flies so fast that it is much nearer twenty years since this danger became a serious menace to steam navigation; it is so insidious in its attacks that after a furnace has been forced down, distorted in grotesque shape, the closest examination upon the steam side of the furnace fails to show what caused it. Furnaces that are apparently without scale, and to which water had clear access, have been bagged time after time in different ships, so that as one engineer said to me "I am afraid to open a furnace door for fear of what may have happened since the last time I was around." The mischief mentioned happened chiefly to marine boilers, but stationary boilers were also injured, though not to so great an extent, for the reason that they were mostly non-condensing, while the larger number of bagged furnaces occurred in connection with surface condensers and high pressures.

The evil mentioned was so great twenty years ago that it almost caused a panic among marine engineers, because its origin was so obscure that no amount of care and attention seemed able to prevent it. At this stage of the trouble vessel owners abroad called in an English engineer, Mr. Vivian B. Lewes, F. R. S., to investigate and report upon the cause and cure of collapsing furnaces. Mr. Lewes ap-

preciated the difficulties before him and set about a solution of them in a systematic way. His report was an extremely valuable one of great length, but no more than a mere outline of it and his findings can be given. Practical men in all branches of the business welcomed it and carefully studied his conclusions from cause to effect. In brief, the cause was the presence of oil on the heating surfaces which failed. When this was announced it seemed anomalous, from the fact that there was no ocular proof that it was a correct finding. There was nothing on the water side to substantiate Mr. Lewes's verdict but closer investigation showed that he was right. The oil used in the cylinders was a patented article stated not to boil under 370 degrees F.; as this was higher than the steam-pressure temperature corresponding to 80 pounds. It was deemed perfectly safe, in that it could not have been deposited on the heating surfaces and then distilled off leaving no trace. The oil was experimented with and found to boil at 248 degrees F.; thus reopening the question as to whether the oil had not been vaporized when the boiler was at work. This was the fact, despite the negative testimony of the furnace crowns, which were still covered with a slight coating of scale that had not been disturbed; but deposits from portions of the shell below the furnaces were extremely greasy, forming in connection with the free dirt and mineral precipitates an agglomerated mass which adhered tenaciously to the plates wherever it struck them. If this happened to be the furnace crowns with an intense heat beneath, the adhering deposit was changed into a spongy, leathery mass, originally a mere film, but soon blown up into a pancake form from which the oil rapidly distilled, leaving the viscous body behind in a pulverulent form, which disappeared wholly with the distortion of the furnace shells. To prove still further his diagnosis, Mr. Lewes took a portion of the deposits in the boiler and covered sheet-iron vessels with them in the form of a wash, and on subjecting such vessels to a high temperature readily burned a hole through the bottoms of them, showing that the coating was a perfect non-conductor.

Having established the cause, Mr. Lewes set about a remedy which would prevent such occurrences in future; this was, in brief, to introduce the feed water through a long pipe filled with coke in lumps, which caught the oil globules and prevented them from entering the boiler. This, in one form or another, is the practice of today; not only is the feed water filtered, but very much less oil is used than was the case many years ago; so lavish was its use then that boiler inspectors have told me that they have opened boilers

which fairly reeked with oil, so much so that when the lower hand-hole plates were removed oil dripped from the tubes. My own experience would corroborate this condition, for, although I have never come across anything quite so bad as that described above I have seen men pour about a pint of oil into cylinder cups at frequent intervals, most of which was of course blown into the heater with the first exhaust.

Sight-feed lubricators have changed this state of things, but there are places where they are not used, or, if they are, they feed too fast. Many persons in charge of steam plants will not use any oil in the cylinders, employing plumbago as a lubricant in lieu of it. This is mixed with water and fed into the cylinders at stated times, but the practice is far from being general, possibly from the fear that the cylinders may be scored; where the packing is of the snap-ring type this is not likely to occur, but if it is jacked out hard against the cylinder walls there is some danger of a catastrophe.

No consideration of the great improvements in boiler practice during fifty years last past would be complete or so clearly recognized without illustrations of the boilers then used. We can see how we groped in darkness, so to speak, for want of precedents. We know now that it was not a superabundance of heating surface that made a lively boiler, but other things in connection with it. The proportions of grate surface to heating surface have not been changed, and science, pure and simple, has not laid down any formulæ which work better than our old rule of thumb. One of the latest text-books, written by a foreign engineer, alluding to this point, says that in the rules furnished the author has endeavored to give the latest discoveries in the science of steam engineering, but has found himself somewhat hampered by their close relation to "empirical practice!"

That is very neatly expressed, and is correct in the sense that a steam boiler is not an invention, but an evolution from certain hard facts and premises, forced upon us by the incontrovertible argument of failure under present conditions; these last being that in the early days we built boilers that did not perform to our liking, and were compelled to go on building them until they did. Trial and error was empirical practice, but we had no other resource, being compelled to blaze our own trail as we went along.

It should not be called empirical practice, or the rule of thumb, which is only a synonym for guessing (success in which resides in the skill of the guesser) but rather, a close diagnosis of the apparent facts, which can be shown correct or the reverse by the immediate

results. Failures are beacons, erected upon mechanical shoals to warn off all wayfarers who may have to pass that way.

For manufacturing purposes the boiler shown in Figure 1 is a fair example of the type used in 1850. As will be seen, it is a drop-flue boiler bricked in, of the dimensions shown in the diagram. The grate was very large for the heating surface, having 19.25 square feet to a total heating surface of 379.45, a ratio of 19.7 to one; notwithstanding this the boiler was a very poor steamer, evaporating only 4.7 pounds of water per pound of coal, and, per pound of combustible, only 5.87 pounds of water per pound of coal. The pressure in the boiler above the atmosphere was 30.7 pounds.

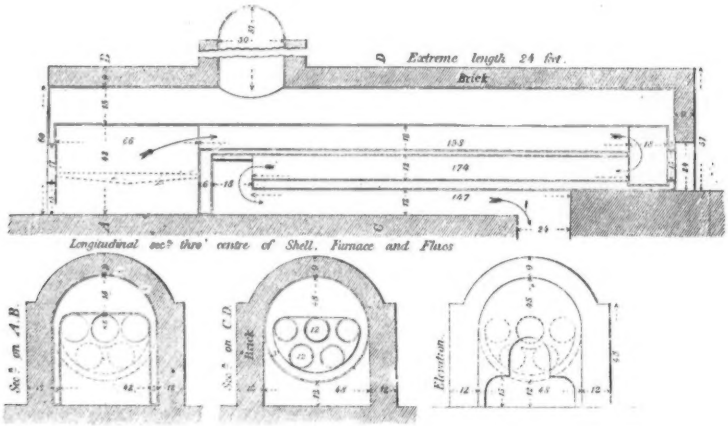


FIG. 1. A TYPICAL BOILER OF 1850.

Figure 2 shows another form of stationary boiler which is a very close approximation to the return-tubular type in general use at the present day; with the exception of the circulating pipes at the water line it is a return tubular boiler pure and simple. These circulating tubes (as they may be called) serve merely as conduits to admit water to water legs extending the whole length of the boiler, a sort of return circulation being obtained through the depending tube entering the pipe connecting both legs just behind the bridge wall. This boiler gave very good results for the day and time, evaporating 9 pounds of water per pound of coal from a temperature of 100 degrees F., and 11.57 pounds of water per pound of combustible from and at 212 degrees F., in spite of its poor circulation, chiefly local. The temperature

in the smoke stack was only 500 degrees F., showing that the heating surfaces acted very efficiently.

The present return-tubular is a popular form of fire-tube boiler for the reason that it is simple to make, steams well, and is easily managed by any person fit to be about a boiler at all; but it has the great drawback of requiring a brick setting, which is not only expensive but needs frequent repairs; it is also difficult of access for thorough inspection and overhauling, but it is more used than any other type, excepting, possibly the vertical tubular.

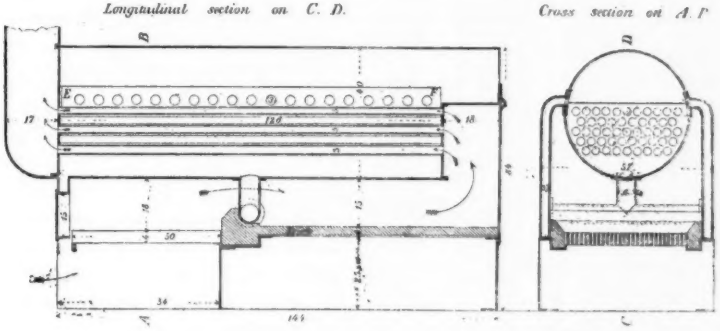


FIG. 2. A PROTOTYPE OF THE MODERN RETURN TUBULAR BOILER.

Mention of this type recalls one invented by an English engineer in 1846; it was reinvented by Thomas Prosser of New York in 1855-6, and again redesigned by Lee and Larned, also of New York, for steam fire-engine purposes. The original boiler was put into an English tug-boat, where it more or less promptly blew up, with what is described as an enormous pressure, to wit—100 pounds per square inch above the atmosphere! It so happens that when Lee & Larned built the boiler at the old Novelty Iron Works in New York I was employed there, and saw these boilers under construction. On one occasion a boiler of this type was standing in the yard under pressure when a workman came along and stopped to examine it; he cast his eye upward and saw that the gauge registered 240 pounds to the square inch and "stood not upon the order of his going" but fled to the uttermost parts of the yard, expecting momentarily to hear the report of an explosion. He never heard it, for that was the working pressure which was always carried; the boilers were strong enough, but wholly impracticable in other respects. A glance shows that the boiler is inaccessible for cleaning, and very difficult to make and

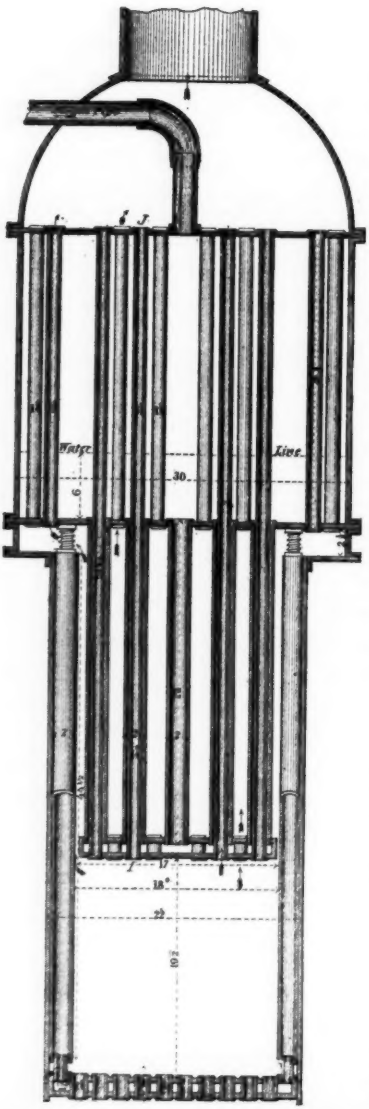


FIG. 3. MULTITUBULAR BOILER OF 1846.

keep tight. If a tube leaked no one could tell which it was, and the boiler was immensely expensive to construct. It was a combined fire and water-tube boiler, the water-tube being inside the fire-tube with only a quarter-inch water space. It was a rapid steamer, getting a working pressure from cold water in five minutes, but it had the disagreeable habit of collapsing the water tubes in considerable numbers every time it was put to work. Quite a number of these boilers were built and used, but there was great opposition to steam fire-engines in those days, and the volunteer firemen refused to act with them. When they were compelled by force of public opinion to adopt some form of steam fire-engine it was not the Lee & Larned. The boiler was emphatically a freak, of no practical utility.

It is interesting to note the progress of the water-tube boiler pure and simple, in the last twenty or thirty years. Asking a steam user to buy a boiler of that kind fifty years ago was looked upon almost in the light of an affront. And yet the type is a very old one. The British Museum has one that was found at Herculaneum which was used for heating water in a public bath; it is identical with modern boilers in general use which have horizontal water-tubes taking into

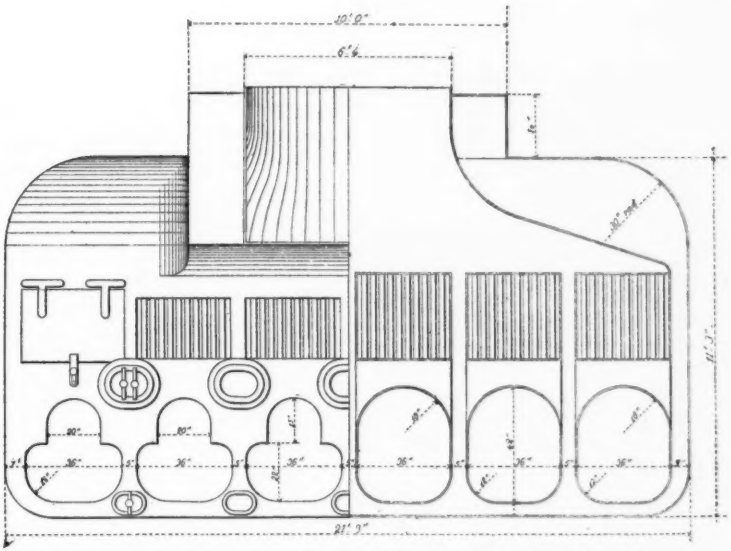


FIG. 4. VERTICAL WATER-TUBE BOILER OF U. S. STEAM FRIGATE SAN JACINTO. FRONT ELEVATION.

vertical water legs. Marine water-tube boilers have made great advances over those experimented with in 1850; the water-tube boiler at that time was identical in weight and external form with the fire-tube boiler, besides having troubles of its own which were by no means popular with steam users. They were not used to any great extent, but found their way into a few naval vessels and some in the commercial marine, from which last they found their way out again precipitately on account of inherent

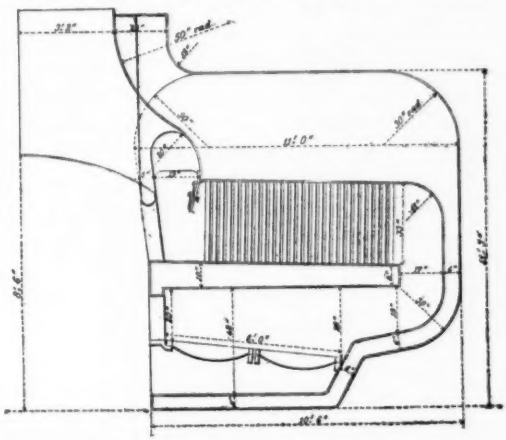
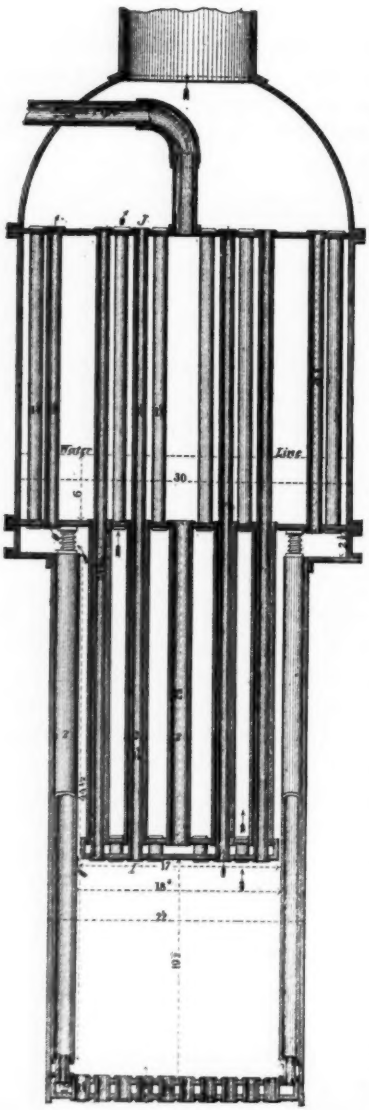


FIG. 5. VERTICAL SECTION OF SAN JACINTO'S WATER-TUBE BOILER.



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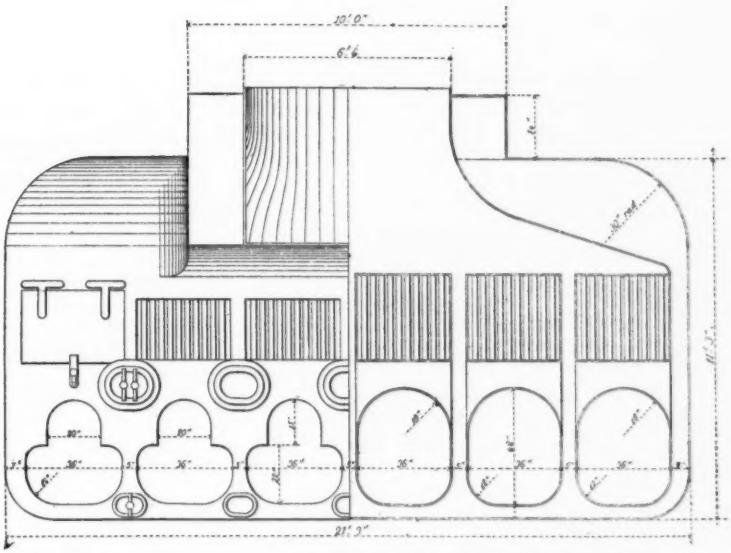

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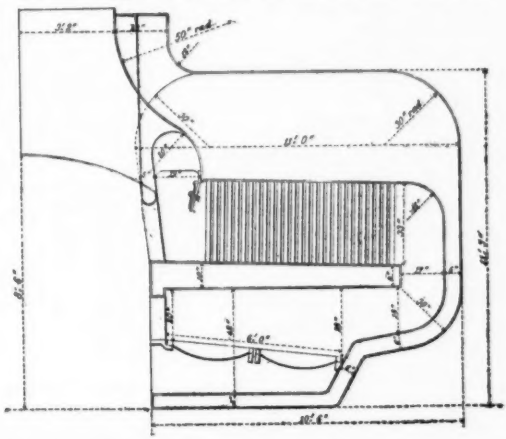

FIG. 5. VERTICAL SECTION OF SAN JACINTO'S WATER-TUBE BOILER.

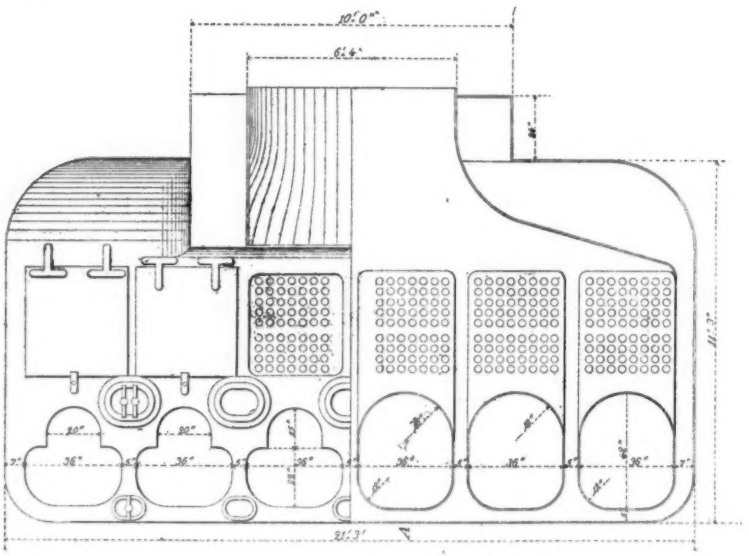

FIG. 6. HORIZONTAL FIRE-TUBE BOILER OF U. S. STEAM FRIGATE SAN JACINTO. FRONT ELEVATION.

defects which were impossible to overcome. The tubes, being vertical and only 2 inches in diameter, soon choked with salty accretions so that they were useless as heating surface, besides leaking profusely in secret places unreachable by the hand of man. These boilers were in the Fulton and Arago, of the Havre line; I have seen them come into port with five or six pounds of steam only, at a time when competition was fierce in Transatlantic trade, and heard the engineers bewail their hard fate in having to

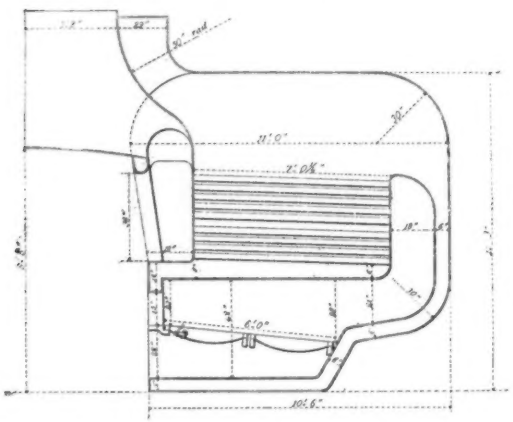

FIG. 7. VERTICAL SECTION OF SAN JACINTO'S FIRE-TUBE BOILERS.

deal with such boilers; they speedily disappeared from public use.

A very great impetus was given to the introduction of the water-tube boiler in the United States Navy by the recent war with Spain. Admiral George W. Melville, then engineer-in-chief of the Navy, said in a report and review of all the events which transpired on sea:

> "I consider the battle of Santiago to have developed the necessity of the use of water-tube boilers, whether it taught us anything else or not. It would have been of the greatest advantage to have had, during the blockade of Santiago, boilers capable of raising steam in less than half an hour. Coal need not have been used to keep all the boilers under steam all the time. The Massachusetts might have shared in the glories of the fight if she had been fitted with water-tube boilers. The Indiana could have kept up with the Oregon and the Texas. The New York would have developed at least three knots more speed, and the Navy would have been spared a controversy. I think the Colon would not have gotten away so far as she did. But we did not have water-tube boilers."

There is much more to the same purport, but this will suffice; since the Admiral's report over half a million horse power of water-tube boilers have been added to the United States navy, consisting of over five-hundred individual boilers of one type, giving entire satisfaction. The diagrams, Figures 5 and 8, represent, respectively, the water-tube boilers in use in the Navy before 1855-6 and those in use at present. There is no comparison between them either in point of efficiency, weight for power, economy of fuel, or facility in raising steam.

The engravings also show, respectively, the water-tube boiler of 1855 and of 1905. The changes, it will be seen, are very marked. The only difference between the water-tube boiler of the earlier period and the fire-tube boiler is the substitution of vertical water tubes in lieu of horizontal fire tubes; in all other respects the boilers are identical. Both have braced and stayed shells, and both occupy the same amount of cubic feet of space, nearly; the weights are practically the same, so that nothing was gained in these directions by the change of type. The evaporation was slightly better in the water-tube boiler, but to offset this it was practically inaccessible for cleaning and repair. Contrast these water-tube boilers of 1855 with those of today, and we can see the progress made in half a century. Every part of this 1905 boiler can be reached for any purpose, and any leaking tube discovered and removed without sacrificing a number of others which are sound; this last defect was very marked in the early water-tube

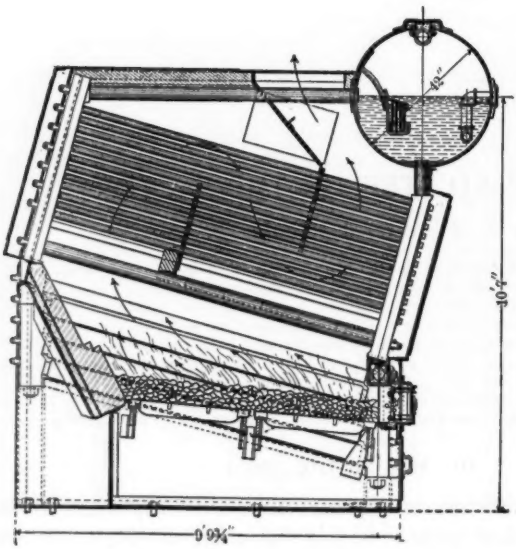

FIG. 8. A WATER-TUBE BOILER OF 1905.
The type shown is only one of many successful forms in use, but has been very largely adopted for the reason that it adapts itself well to conditions of space.

boilers. Moreover, the water-tube boiler of to-day has far greater efficiency than its antitype. It is less than half the weight, has neither braces nor stay bolts in it, and has a longer radius of action per ton of coal carried. It can be brought into action in ten minutes from no steam to a working pressure, while the old fire-tube boiler required many hours for the same duty. This is the boiler spoken of in a previous paragraph as being largely used in naval vessels, and so far it has justified the adoption of it by the Government.

In the space available for contrasting boilers of the past and the present, it is manifestly impossible to mention all variations from approved types, for these last are almost as the sands of the sea in number. Many of them had excellent features, but the inexorable fiat of daily practical use displaced them sooner or later. Those which survived for a time eventually exhibited signs of premature degeneration and signed their own warrants of dismissal from service. The boilers are emphatically the lungs of a ship; if they are congenitally weak, no chances are taken with them; they are thrown out, no matter what their first cost was.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker and Walter Brown.

In the present article, which is the third of a series containing a very valuable practical study of the use and effects of high-speed tool steel in one of the largest American machine shops, the details of introducing the new steels, both with regard to the men and to the machines, are discussed. The first article, which appeared in September, showed that, in general, the factory manager will find it to his advantage to replace carbon by alloy steel only gradually, under expert advice, and to adapt his existing equipment to the new conditions as far as possible, and work it to the limit until it is worn out. The second article dealt with the internal adjustment of shop conditions—both as to men and as to jobs—to the use of the new tools. The third, now presented, takes up the actual handling of the tools.—THE EDITORS.

III. MAKING THE TOOLS.

NO man of sufficient intelligence to be a factory manager or superintendent needs to be told that under suitable conditions of manufacture it is cheaper for a user to make his own tools than to buy them made to order. But such suitable conditions do not always prevail, especially in the small factory; and it happens therefore that it is often more economical, as well as more satisfactory from other considerations, to purchase tools in preference to making them.

The production of tools from high-speed steels is not really a trade in itself, but it differs markedly in certain of its aspects from the manufacture of carbon-steel tools, and requires, for the attainment of satisfactory results, appliances and knowledge not necessary to the latter. At least, this is the case in respect to any but the more simple forms of tools. These latter usually require little in the way of special appliances. The same special knowledge requisite for the more complicated forms is however necessary in the treatment of the simpler ones. The question of buying *vs.* making high-speed tools, therefore, can only be answered according to the conditions prevailing in each individual plant. In the large factory, the tool-making equipment is quite likely to be adequate to the new requirements, or may readily be made so; and the toolsmiths already employed can be brought to acquire the requisite skill in handling the new material; so that in such a factory the question does not usually arise. Even the small factory requiring a considerable number of metal-cutting tools

will have a tool dresser in the shop, though very likely lacking facilities for the production of any but the simplest forms. These the toolsmith can learn to make of high-speed steel just as readily as of any other material. But he must learn—unless indeed he has been fortunate enough to have already acquired the new knowledge and skill. Thus equipped, there is no reason why the small shop should not manufacture most lathe, planer, shaper and similar tools.

When first put on the market, the alloy steels were usually sent out unannealed, just as the bars or rods came from the hammer or rolls. It was a common practice to cut or break off pieces of a suitable length, grind to the required point, and use the steel thus without heating or any other further treatment. Generally such tools did pretty good work, but frequently the results were not all that could be desired. Hence arose the complaint of unevenness in the quality of the new steels—a complaint that has almost entirely disappeared since the practical withdrawal of the unannealed stock from sale, and the consequent necessity for proper hardening before using in the machine. The makers, regardful of their own interests, prefer to send out the annealed stock because it hardens better and is less liable to fail from internal strains set up by the rolling or hammering, and will therefore give better results and in consequence increase the demand. The unannealed stock is still to be had; but there is rarely any advantage in using it. The annealed stock on the contrary has the advantage of permitting the bar to be nicked and broken off, thus avoiding the necessity of heating and cutting in the usual manner. Furthermore, the unannealed bars may be machined either with or without forging, and the tools made from them have less liability to breakage in the shanks or necks under the heavy strains imposed by the high duty required of them. This high duty, the tremendously increased stresses under which the new tools will be working, makes it important to use bars of greater cross section than formerly; for while the high-speed steel is tougher and harder than carbon steel, the strains resulting from the increased speeds and feeds are usually much greater than this additional strength will compensate for.

Next to the material itself, the most important factor in the successful use of high-speed steel for tools is the toolsmith. Unless the tools are properly made after intelligent design, little but disappointment can be expected. He must be not only a good workman, but of a receptive mind. All that he knows about carbon steel will help him little in working with the new alloys. The color scheme that served him so well in working with ordinary steels not only will not serve him when applied to the new steels, but if applied at all will lead to

utter failure. He must give up most of his previously acquired notions on the subject of tools, and give himself to the acquisition of the new methods required by the new qualities and properties with which he has to deal. Fortunate the shop that starts out properly equipped in this respect.

The former practice of using stock direct from the bar, without forging or heating, is now necessarily superseded because of the almost exclusive use of annealed stock. This requires heating anyway, in order to harden it properly, and it is therefore more economical to forge the tool to about the shape required and then grind it to a cutting edge than to grind it to shape. The fire for this heating need not differ essentially from the ordinary forge fire. Any good forge will give the required heat, for small tools at any rate. The important thing is to bring the heat up gradually so that the whole mass of metal to be worked shall be uniformly hot. It is in this particular that an ordinary forge fire is not always satisfactory, particularly as regards large tools. The heat does not penetrate the interior uniformly because of the difficulty of applying it equally to all sides at once. This difficulty can be largely overcome by laying up a hood of fire brick so as to form a sort of small enclosed furnace. Such a hood helps to keep away currents of air and prevents much surface radiation. A regular and clean fire supported by plenty of fuel is essential to good work. The heating should proceed as rapidly as may be without over-heating the corners. The fire must not be too keen, or it will not heat through until after the outer portions of the piece have been hot enough for some time, and very likely damaged by the melting of the edges; neither must it be too slow, for in that case the tendency is to heat the tool farther up into the shank than is desirable.

The proper degree of heat for forging lies within a range of colors reaching from, say, a bright red to a bright yellow. No hammering should be done at a heat below the former, for the tendency will be to develop flaws and fine cracks.

For hardening a very different heat is necessary. The heating can still be done in a fire such as has been described above; but better results are obtained by the use of more or less specialized furnaces. The hollow fire is really indispensable for this purpose. However, it need not be an elaborate affair, especially for use with the simpler forms of tools. Such an one as described above, formed around an ordinary forge fire, works very well in the case of simple lathe, planer, and similar tools that require no machining. Even in such cases a makeshift of this sort is of doubtful economy except possibly where but a very few tools are to be made. A properly designed furnace will

give much better results, and will therefore pay for itself in a short time, even in the small shop.

The heating is carried to a point where the steel shows a clear white color and the surface begins to flux. This will be just short of the melting point. Certain makes of high-speed steel reach a good hardening heat somewhat short of the white color; but in all cases the heat should be high enough to make the flux run. As in the forging heat, care must be taken that the heating be gradual, uniform and thorough. How far back into the shank the tool is to be heated will depend upon the stock used. Usually, if unannealed, it is better to heat only at the point, so as to leave the neck and supporting part as thoroughly annealed and tough as possible. If, however, the unannealed stock be used, it is better to heat a considerable distance back from the point, farther by quite a little than it is to be hardened, so as to leave that part as soft as may be. Some brands require, or at any rate are better for, this treatment always. The direction papers sent out by the makers will usually indicate when it is desirable.

For the more elaborate tools, those of special forms and also those requiring to be machined before hardening, good practice indicates the use of special methods of heating, or at least the use of a properly designed furnace. It is presumably well understood that all tools with projecting edges or gained surfaces, such as drills and milling cutters, are peculiarly susceptible to cracks from the internal strains set up during the hardening process—cracks that sometimes do not appear until long after the tool has been set to work. It is therefore important to take all possible precautions to prevent such strains as far as possible by the use of approved methods and appliances in preference to the simpler forge fire already described.

The form of the furnace is immaterial within certain limits. The important considerations are that it shall be economical in fuel consumption, heat uniformly and thoroughly, and be easily accessible for the insertion and removal of tools as well as for inspection.

With respect to the fuel used there is much to be said in favor of coke and anthracite coal. The oil furnace is practically out of the question because of the difficulty of heating its contents uniformly enough to meet the requirements of the class of tools now under consideration. A good gas furnace will be suitable under ordinary circumstances. It must, however, be so designed as to avoid currents of air about the heating tools. Because of the difficulty in meeting this requirement, it is generally less satisfactory than the coke furnace except when the tools to be hardened are enclosed in sealed cases as hereafter shown. A useful form of coke furnace is shown in Figure 3.

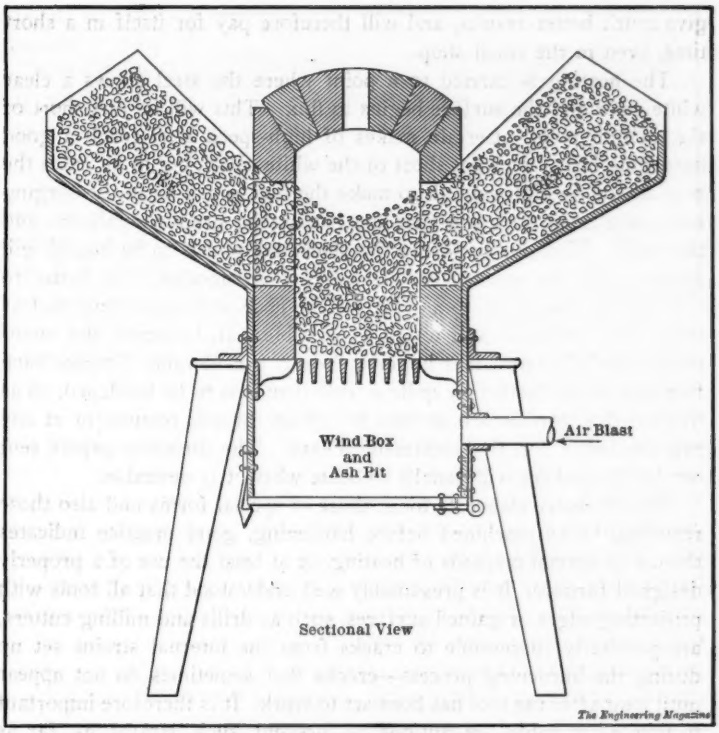

FIG. 3. COKE FURNACE FOR HEATING HIGH-SPEED-STEEL TOOLS.

Either anthracite or coke may be used. The fuel is fed from the hoppers above, passing down at each side and forming a hollowed bed of coals at the bottom. With grate bars having small (and many) openings, so arranged as to permit the ashes to be easily dumped into the completely closed ash pit, the best possible fire is obtained. If designed with some arrangement for suspending the tools so as to prevent their coming into contact with the fuel, it can be used for every kind and size of tool.

If there be no arrangement for so suspending them, or if a gas furnace be used, it will be found desirable to resort to some expedient to keep away from the fuel, and from the unburned air always found in the latter, all such tools as require accurate sizing or would be injured by possible slight distortion. A good way of doing this is to enclose them in a piece of wrought pipe, packed closely with charcoal or small coke, and sealed with fire clay. If much hardening of this

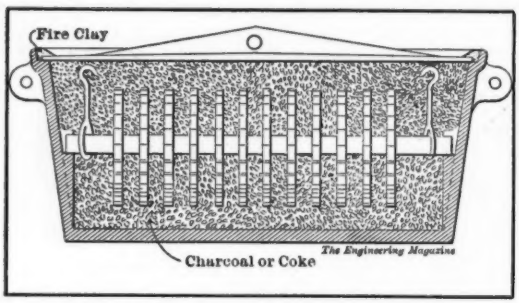

FIG. 4. PACKING CASE FOR HARDENING TOOLS.

sort is to be done a suitable pot should be made for the purpose, something after the style shown in Figure 4. The milling cutters shown in this illustration are suspended from a rod supported at both ends, provided with hooks to facilitate rapid handling when ready to take out. The tools ought not to be in contact with each other, so that the heat can penetrate uniformly, and for the further reason that in the subsequent hardening the cooling agent also can come in free contact with all surfaces so as to avoid the internal strains likely to be set up by uneven cooling. Such a pot could be cast; but if of wrought iron there is no danger of the bottom dropping out. The pot and its contents are placed in the furnace after the latter has been raised to a white heat, and left for three or four hours, according to size. No positive rule can be laid down respecting the exact length of time for the heating. The operator must be guided by his judgment and previous experience. The old expedient of withdrawing from time to time wires inserted in the pot for that purpose is frequently useful in showing the condition of the contents. A pyrometer would of course be of advantage here; but the cost of one that is always reliable and is at the same time easily kept in repair is considerable—greater than most managers will care to assume in the early stages of their high-speed-steel experience. Such an apparatus, however, is of great value in the production of tools of uniform quality, which certainly is a desideratum in a well conducted shop. Refined methods are much derided in certain quarters; and it is conceded that such a thing as over-refinement is quite possible. A tool that is "good enough" for the work required of it is just as good as if twice as much expense had been incurred in making it. But it *must be* good enough for that work, or it becomes a very expensive tool by reason of the material it spoils. For very accurate work, therefore—that is, for tools that need to be closely sized and of uniform quality—refined methods and appliances represent money well spent.

Now a word as to the reason for casing or otherwise protecting accurately made tools. Nearly every worker with high-speed steel

has noticed and doubtless remarked upon the pitted appearance frequently seen on tools after heating. The explanation of the phenomenon is very simple. The pits are caused by the scaling, that is, the oxidation of the steel in the presence of air. Under the high heats to which the steel is subjected, the oxygen of the air blast attacks the metal with great activity, and forms scales, leaving the pits beneath. A similar effect takes place when the steel is left in contact with the fuel through which air is passing, as is always the case in a coke or coal fire; or with which air is mixed, as is the case with gas and oil. In the oil furnace the blistering and pitting effect is especially noticeable. The only satisfactory way to prevent this action in such a furnace is by the use of a muffle or the packing case described.

And now we come to the hardening of the tool. For this process, as for the heating, very simple apparatus can be made to serve. In fact, some excellent results have been obtained with no apparatus at all, for most makes of the new steels harden with tolerable evenness on exposure to the air merely. Of course the degree of hardness depends somewhat upon the rapidity with which the cooling takes place, and the air should therefore be as cool as may be, and preferably in motion. Even then, however, the tool is likely to be softer than it ought to be to get good results on certain kinds of work. It is much better to use air under pressure. Air supplied from a blower does very well; but compressed air is better. It cools the tool more rapidly, and can be better directed to the exact place required. It is a very convenient hardening agent, is recommended by the makers of nearly all brands of high-speed steel, and has but two disadvantages, neither of which seriously affects its usefulness: the cost, and the oxidation of closely finished tools. As already pointed out, heated steel and the oxygen of the air combine readily, and an expensive and accurate tool may easily have its precision affected in the air blast. The cost of air is usually overlooked in shops, particularly where relatively little is used; but it is really an expense that needs to be considered. Compressed to gauge eighty pounds at the nozzle, such air costs about eighty cents an hour when flowing freely from a half-inch opening, reckoning the charge at four cents per thousand feet of free air. The evaporation from the oil bath is insignificant, and the expense of replenishing almost negligible: whence it follows that considerations of economy would indicate the use of oil. Furthermore, many makers recommend the use of oil in preference to air for all finishing tools and such others as require subsequent annealing or "drawing." Experience approves the recommendation.

No special appliances are necessary for use in connection with the

simpler forms of tools, except that it is desirable to have some arrangement whereby the oil can be kept in motion and sufficiently cool. Air bubbling up through it will do this satisfactorily. Even this is unnecessary if only a few tools are to be hardened. Fish oil serves the purpose as well as any other. The chief thing is to have the bath near at hand, so that as soon as the tool reaches the required white heat it may be at once quenched. The immersion should be vertical and gradual in the case of all long tools. It is not safe to submerge the tool beyond the point to which it has been properly heated, either; for cracks or checks are quite likely to result. The immersion should continue until the tool can be handled safely. Further cooling can take place in any dry place. The tool is ground dry.

Those tools likely to be affected by oxidation, having been heated in a muffle or packing case, are removed as quickly as possible and *plunged* into the bath, remaining until cool enough to handle. Care must be taken that when dipped they are not (in case of several being suspended and hardened simultaneously) in contact with each other. It is important that there be free contact of the oil with all surfaces of each piece; otherwise there will be unequal cooling and consequent internal strains, with the inevitable cracks, as already pointed out. Of course such tools could be packed for heating without suspension, and hardened separately; but if this be done there is no assurance of uniformity in the hardening. The last pieces dipped will certainly be somewhat cooler than the first, and will furthermore have been exposed to the oxidizing influence of the air while waiting their turn.

For such shops as make many tools, a properly designed oil bath is a necessity. Figure 5 illustrates the essential features of a satisfactory arrangement—namely, an oil tank of suitable size suspended in a larger tank filled with water. The cooling tank is provided with suitable intake and overflow for circulating the water. The oil is kept in circulation by air bubbling up from below.

A peculiarity of the alloy steels is that the fitness of a tool for its particular work does not necessarily depend upon its degree of hardness. Indeed, some of the best results have in certain instances been obtained from tools soft enough to take a file. It must not, however, be inferred that softness is usually a desirable quality in such tools. As a matter of fact, under ordinary circumstances any considerable degree of softness results in the tool quickly "gumming," particularly in the case of reamers, drills, and other tools subject to a great deal of friction while working, with the result that the tool is soon spoiled. Only experience will determine just what is best. It is, however, a safe rule to make all tools as hard as the shape and use will admit. It

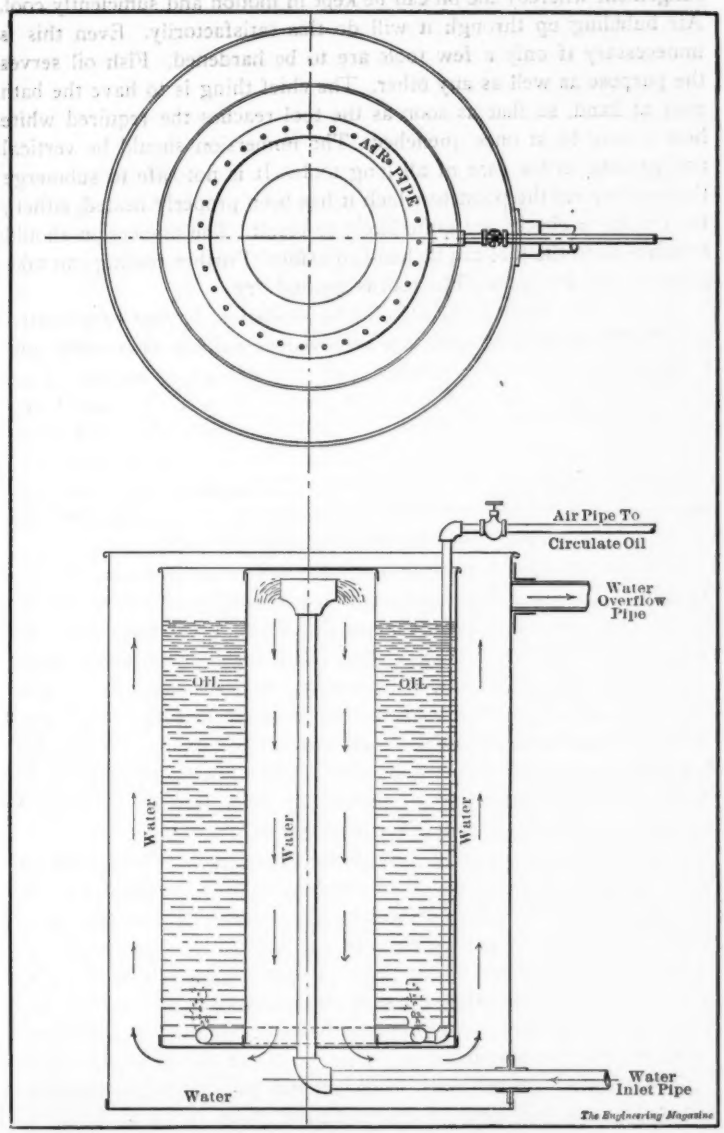

FIG. 5. OIL BATH WITH WATER COOLING DEVICE.

is obvious that thread-cutting dies, taps, and most cylindrical or circular cutters with small cutting edges, must be soft enough so that these edges will not crumble. Since the hardening process permits but little amplitude in respect to degree, it is necessary to resort to the old expedient of "drawing."

HARDENING RECORD

TOOL,_____ SIZE,_____ STEEL,_____

FOR PC. NO._____ OPERATION NO._____ DEPT.,_____

HARDENING FURNACE,_____ HARDENING HEAT,_____

COOLING AGENT,_____ TEMPERATURE,_____

TEMPERING FURNACE,_____ TEMPERING HEAT,_____

MEMORANDA:

DATE,_____ TOOLSMITH,_____

The Engineering Magazine

FIG. 6. FORM FOR RECORDING HARDENING DATA.

Up to this point in the making of the tools no good toolsmith need have gone far astray. Unless uncommonly cautious, however, or provided with accurate heat-measuring apparatus and reliable reference tables, he is very likely to experience much trouble, and in the beginning to make many failures, in tempering the new steels. His experience with carbon steel will not avail him in the tempering of high-speed tools. Indeed, unless unusually careful he is likely to be constantly misled by that experience, because the colors indicating proper heats for the latter are quite different from those he has been used to. As a matter of fact, color is not a safe guide anyway, in treating the new steels. There are so many possible variations in temper within a range of color scarcely distinguishable to the eye, that if anything like uniformity is desired it is necessary to use temperature gauges and to preserve records of experience. In the absence of any special conditions or requirements it will usually be safe to draw formed cutters, taps, threading dies, drills, reamers, milling cutters, and similar tools to a dark straw color, which represents about 260 degrees Centigrade. A study of the performances of various tools as shown by the records described in a former paper, in connection with suitable memoranda relative to the treatment of the particular tools, will lead to the determination of suitable standards for the various kinds of work. It

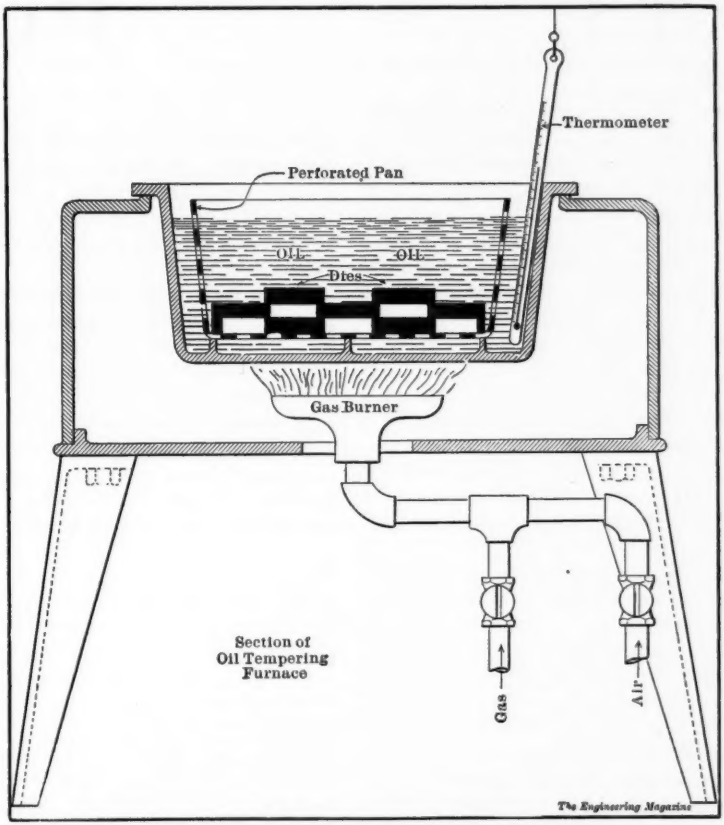

FIG. 7. SECTION OF OIL-TEMPERING FURNACE.

will be found that the tools requiring the greatest toughness, like taps for instance, will need to be drawn much farther than usual, sometimes as far as 350 degrees C., or until the steel shows a slight greenish tinge. A suitable tool-tempering record is shown in Figure 6.

The most exact methods are none too good for making the best tools. The furnace described above may be made to meet the most exacting requirements, if provided with all the necessary arrangements for regulating and measuring temperatures. A simpler and less expensive arrangement, furthermore one that is found by experience to be much more convenient and less likely to need costly repairs, is the oil tempering furnace. A good type of such an apparatus is illustrated in Figure 7, which is perhaps sufficiently self-explanatory.

EDITORIAL COMMENT

MR. WALLACE'S article, which appears in the leading position in this issue of THE ENGINEERING MAGAZINE, will be immediately recognized as having a most important meaning in the present state of the Canal question. It is, perhaps, the most significant of all the striking contributions to the subject which we have had the honor to publish during the past nine years—not only because Mr. Wallace has had larger opportunities than any other living engineer to measure the undertaking as a work to be done by the United States, but because what he reveals throws a new and long-awaited light on the real possibilities and the very real dangers of the situation.

Mr. Wallace's direct and straightforward statement covers three main points :—

First, he summarizes briefly what was actually done during his year of residence on the Isthmus—the first year of actual work by our Government. He states the total result accomplished, and the general unit costs determined. This condensed record of progress, coupled with what Mr. Wallace has previously written for our pages, will give the friends of the enterprise, whether in or out of the engineering profession, a broad idea of the present status, as well as a basis for further study and comparison.

Second, he offers a brief synopsis of his conception and plan in attacking the construction work, and of analyzing the records of this experimental period so as to enable a sound decision to be made upon the choice of the type of canal and the methods of building it. This demonstration of the commonsense of civil-engineering methods will certainly carry home a lively conviction of the way in which the work should be approached—and, we hope and believe, a controlling determination to insist on the maintenance of the best engineering standards in the completion of constructive work on the canal.

Third, and most immediately important, he points—with restraint, but yet so clearly that no reader can be mistaken in the meaning—to the disastrous influences of "governmental red-tape," which have stood squarely in the way of carrying out this practical and necessary policy. In so doing, Mr. Wallace evidently indicates, briefly and temperately, certain reasons which compelled his retirement from a position which he could not continue to fill without danger, as it appeared to him, to his reputation, nor without compromise of his ideals.

> "It should be plainly evident that Governmental methods which require from ten to twelve years to complete a structure such as the Federal building in Chicago—which, under private individual ownership and control could have been erected in the space of a single year, at most two—cannot be applied to the construction of the Panama Canal with satisfactory results, if the present generation is to derive benefit from its accomplishment, and at reasonable cost."
>
> *John F. Wallace.*

It is profoundly to be regretted that into the negotiations looking to a retirement which was unquestionably Mr. Wallace's professional privilege, and which might have been accomplished without any prejudice to the Canal enterprise, there should have entered elements forcing a situation full of peril not only to personal and professional reputations, but to a National undertaking.

But this unfortunate event is not to be permitted to deprive the country of the invaluable fund of knowledge of the Isthmus, especially of the Canal work, which Mr. Wallace possesses, and which would be lost to the country without his report. It appears that the lack of opportunity to draw freely upon this fund has already cost the Advisory Board valuable time and effort. At best, they can have received only fragmentary studies, representing no doubt careful and painstaking work, rich in valuable detail, but after all only the partial contributions of assistants, none of whom saw the complete plan of study nor the exact relations which his work bore to the entire plan. The Administration, the Advisory Board, and the country, will receive the full benefit of the past year's work only by receiving Mr. Wallace's own report, and its interpretation.

At the moment of going to press, we learn that this happy result is secured.

* * *

It is generally admitted that extended practical experience is necessary in order that any mechanical device may be perfected, and engineers of all men realize the great value of working tests and trials of operative machinery. Such tests, however, should be conducted upon both scientific and practical lines, one of the important results sought being the elimination of what may be called "freak" constructions and ideas.

In the course of the development of the automobile it has unfortunately been assumed that valuable information would be acquired as a result of elaborate speed-trials and races, and this view has not been discouraged by those interested in the production of sporting vehicles and the conduct of road racing. As a matter of fact, the racing automobile is necessarily a freak, designed to meet the sole requirement of maintaining a maximum speed for a limited period of time, and the race once over the winning machine becomes as uninteresting as an exploded fire-cracker on the fifth of July.

In this respect there is not much difference between automobile racing and the various yacht races which are held from time to time in connection with that ungainly piece of silverware known as the Queen's Cup. There are few, even among the most enthusiastic yachtsmen, we believe, who would venture to affirm that the international yacht races contribute any information of value in connection with the design even of pleasure yachts, while the intrinsic worthlessness of the cup challengers and defenders themselves is clearly shown by the insignificant prices which they subsequently bring when offered for sale.

It is worthy of note that at a time when automobile racing is being encouraged in the United States it is already being superseded in France by the far more intelligent work of the Automobile Club in the conduct of extended road trials of industrial and military vehicles. We have given elsewhere in this issue a review of these important and valuable investigations, which should appeal both to the engineer and the manufacturer in a way which no speed trials can possibly do.

It does not require a succession of wild rides over country roads to demonstrate to intelligent people that higher powering will enable higher speeds to be made, but it is necessary to put industrial automobiles through exhaustive and continuous tests to determine the elements required for endurance, economy in cost and operation, and efficiency in daily service. The army engineer demands a machine which can be operated in a rough and arid country, which can pull itself out of holes, and which will not get stuck in the mud. The truckman requires a vehicle in which the paying load shall be a maximum, and the wear and tear a minimum, while in all cases the industrial automobile must show itself the superior of the

horse or even of the despised army mule, before it can be held to have met the commercial demand.

The manner in which this question of reliability trials is regarded in France is shown by the remarks of the Marquis de Dion, after the conclusion of the recent tests of industrial vehicles. Referring to the influence of this year's trials the veteran automobilist says:

"By next year we shall undoubtedly see the results of this idea, and we shall organize a much greater series of trials for endurance and reliability, over a course of 5,000 kilometres in length, the daily runs being from 300 to 400 kilometres. All the parts of the vehicles will be registered, and no repairs will be allowed except those which can be made by use of the appliances carried on the vehicles themselves. An average speed of 35 to 40 kilometres will be required, according to the various classifications, and these requirements will be checked by secret supervision and timing. In this way we shall prevent the vehicle which is really reliable and trustworthy from being beaten by some dangerous monster which is broken down for a part of the time, and then driven at a speed of 100 kilometres to make up lost time.

"In this way a preparation may be made toward the true evolution of the automobile, diverting it from the high-speed racing tests now so much in vogue, toward a more useful and valuable service."

When such opinions as these are being expressed in France, the country of the development of the racing machine, we may well hesitate before encouraging road racing in the United States. There is no reason why the practical abilities of the American engineer should not be turned directly to the proper field for automobile experiment, without foolishly repeating what has already had its day on the Continent.

AN article in *Engineering News* last June called attention to the fact that some 40,000 engineers are already practicing in the United States, and at least 15,000 students were then preparing to enter the profession. Doubtless since the schools of the country assembled for the winter courses, this number is considerably increased. The *News* drew, as the main conclusion, the deduction that the majority of young men now studying for the engineering field "must eventually find positions requiring fully as much knowledge of business as of engineering, and that our engineering colleges should recognize this by giving their students better training in business methods."

This is substantially the proposition which we have more than once advanced, in urging specifically upon the notice of our larger technical schools the claims of "production engineering" as a recognized and individualized course. We should be inclined to transpose the recommendation as phrased by the *News*, and define the modified course not as "business methods applied to engineering," but as "engineering training specialized to the management of manufacturing or productive industries." But whatever the terms used to express the idea, there can be no question that the time is ripe for one or more of our larger technical colleges to give it substance. There is an increasing demand for the close scientific management of large engineering works and manufacturing plants, and the training which will fit the student for entry into that field should be as distinctly differentiated as that which prepares him for stationary steam practice, marine engineering, or electrical work. The situation is not unlike that which existed when electrical engineering was first made a distinct subject. The wonder is that the schools are so slow to recognize it.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

EFFECTS OF HIGH TEMPERATURES ON STEELS.

INVESTIGATIONS ON THE INFLUENCE OF HEAT UPON THE ELASTIC PROPERTIES OF STEEL.

B. Hopkinson and F. Rogers—Royal Society.

AS an interesting indication of the manner in which the methods of the physical laboratory are being applied to the solution of engineering problems, the work which is being done by Messrs. Hopkinson and Rogers in investigating the elastic properties of steel at high temperatures may be noted. In a recent communication to the Royal Society there is given an account of the researches which are being conducted in this direction, and although the work is by no means completed it is of immediate interest and value in its present form.

"Hitherto investigations into the elastic properties of metals have been confined to comparatively low temperatures. Gray, Dunlop, and Blyth have measured the modulus of rigidity and Young's modulus for wires up to temperatures of 100 degrees C., and found that both these quantities decrease as the temperature rises. Martens determined the influence of heat on the strength of iron up to temperatures of 600 degrees C., but his experiments were the ordinary tensile tests carried to rupture; and though he also found a substantial diminution of Young's modulus with rise of temperature, he did not go into the point fully, being mainly concerned with breaking stress and elongation.

"In the experiments here described the elastic properties of steel and iron have been investigated at higher temperatures, ranging up to 800 degrees C., and for stresses greatly below that required to rupture the material. It is found that as the temperature rises the stress-strain relations undergo a remarkable change, which may best be expressed by saying that what is variously called the time-effect or *elastische nachwirkung*, or creeping, increases greatly with the temperature. Steel at high temperatures behaves like india-rubber or glass; if it is stressed for a time, and the stress removed, it does not at once recover; but after the immediate elastic recovery there is a slow contraction perceptible for many minutes. Such creeping can be detected at ordinary temperatures, but at a red heat it attains a different order of magnitude, becoming (in its total amount) a substantial fraction of the whole deformation."

The experiments of Messrs. Hopkinson and Rogers were conducted with the aid of an electric resistance furnace, the test specimen being placed in a vertical position in the middle of a resistance composed of three coils of nickel wire, this enabling satisfactory control of temperature to be maintained. The apparatus permitted the rapid application of loads up to 1½ tons per square inch to be made, while an extensometer of Professor Ewing's pattern enabled changes in length to be measured up to the 50,000 part of an inch. The interior of the furnace was closed from the atmosphere by means of mercury seals, and the test piece was surrounded by an atmosphere of nitrogen, in order to prevent oxidation.

The trials, so far as made public, have been made upon two kinds of material, one

being steel containing about 0.5 per cent. of carbon, and the other being Low Moor iron. The results are shown in diagrams accompanying the original paper, from which some interesting deductions may be made.

The maximum temperature of the trials was 750 degrees C., the bar being loaded up to about 1¼ tons per square inch for one minute and then unloaded for two minutes, this sequence being repeated a number of times, giving a curve showing the resulting changes in length in terms of time. Even at this low stress the metal is shown to flow fairly rapidly, and the overstraining has a considerable hardening effect, this appearing in the diminishing amount of permanent set reproduced by the successive loadings. The hardening thus produced disappeared with rest, so that if the test bar is permitted to remain unstressed at a temperature of 750 degrees C. for a few hours after having been hardened by successive loadings, it is found to be restored to its original soft state. This flow of the metal is very much slower with a slightly lower load.

"In respect of all the features hitherto mentioned the properties of the material differ only quantitatively from those of the cold bar. The results might, but for one remarkable difference, apply to a cold bar stressed to its yield-point. The difference lies in the behavior of the bar after the removal of the load. The cold bar does not contract appreciably; there is the instantaneous elastic contraction, then it stops. The hot bar, on the other hand, goes on shortening for two minutes or more after the load is off, as shown by the dotted line on the diagram, and the total amount of such shortening amounts to roughly one-third of the instantaneous contraction, or one-quarter of the total contraction, or one-fifth of the average total extension after hardening has taken effect.

"The iron bar behaved in much the same way, but the metal flowed at a lower stress. There was considerable flow with a stress of but half a ton per square inch. The shortening after removal of load was also perceptible at that stress.

"At 600 degrees C. both bars exhibited greater tenacity. A load of 1.6 tons per square inch applied to the steel bar for one minute produced an immediate extension of 3.8 extensometer divisions, followed by a slow drawing out which amounted in one minute to about 0.9 division. On removal of load there was an immediate shortening of 3.8 divisions, followed by a slow contraction amounting in two minutes to 0.7 division. The permanent extension produced was very small, if, indeed, there was any at all. The iron bar behaved in a similar way, but, as at 750 degrees C., it yielded appreciably at a stress which was not sufficient to permanently deform the steel bar.

"The experiment on the steel bar at 600 degrees shows pretty conclusively that this slow recovery after release from stress is not solely, or even mainly, dependent on overstrain. It seems to exist to a large amount with stresses which leave practically no permanent effect; the strain develops slowly under application of stress and disappears slowly after it is removed.

"This phenomenon is, of course, analogous to residual charge in glass and other dielectrics; the stress corresponding to the electric force, and the strain to the electric displacement. Whether the law of linear superposition of the effects of stresses—closely followed in the electrical analogy—is true for hot steel or iron, is an interesting question which the apparatus was hardly sufficiently delicate to answer.

"The magnitude of this effect in steel may best be gauged by comparing it with other cases of the same kind—*e. g.*, with the slow recovery of a glass fibre after twisting; if such a fibre be twisted through a considerable angle for several hours, it will recover all but one-fiftieth of the twist within two or three seconds of the removal of the stress. The remaining slow creep, amounting to one-fiftieth of the whole deformation, corresponds to the slow return of the steel. In india-rubber, under certain circumstances, 10 per cent. of the strain disappears in time after the removal of the stress. But in steel at 600 degrees C. the proportion is about 15 per cent.

"Another effect of 'creeping,' is to make the determination of Young's modulus a matter of some uncertainty. Thus the extension of the bar at 600 degrees C., produced by a given load varies 15 per cent. or more, according to the time of application of the load. When, however, the load

is applied for a very short time—say of the order of one or two seconds—the strain produced seems to approach to a definite limiting value, which is the instantaneous extension or contraction of the bar observed in our experiments when the load is applied or removed. It seems reasonable to define Young's modulus for a metal in this state as the stress divided by this limiting instantaneous strain. It is then independent of the manner of loading, and is a definite physical constant; otherwise not. Owing to the effect of the ends, the reciprocal of the extension is not quite proportional to Young's modulus, their ratio being somewhat greater at high temperatures than at low, as already explained. With regard to this question it should be noted that the error in the determinations on the cold bar, and at 400 degrees C., is probably not more than about 2 per cent. At higher temperatures the error is greater, as, owing to the rapid drawing out of the bar, it was difficult to be sure of the instantaneous extension. It is, however, fairly certain that the ratio of Young's modulus in the cold bar and at 750 degrees C. is not more than 10 per cent. in error.

RAILWAY SHOP ORGANIZATION.

PRACTICAL EXPERIENCE IN THE ORGANIZATION AND ADMINISTRATION OF RAILWAY SHOP FORCES.

H. T. Bentley—Western Railway Club.

IT is beginning to be realized in railway shops as well as in other engineering establishments that an effective organization is an essential feature in economical administration. Private establishments are generally in advance of incorporated companies, just as the latter are undoubtedly ahead of works under government control, but in the long run it will undoubtedly be found that a united and harmonious action of all the elements of a manufacturing establishment make for efficiency, whether the concern be run by an individual, by a company, or by a government.

In a paper recently presented before the Western Railway Club by Mr. H. T. Bentley, this question of shop organization is discussed with especial reference to the requirements of the railway shop, and an abstract of the paper will be found of value and interest.

"In getting together a force of men sufficient to man a shop capable of turning out say 20 to 50 locomotives a month (it really doesn't matter how many engines the shop turns out, the building up of an efficient force is very necessary in all cases), the first consideration is to pick a man for the head, whether as general foreman, master mechanic or shop superintendent, who can be implicitly relied on to carry out the plans you formulate for him, and to have such ideas of his own that he will immediately see where delay or friction occurs and apply a remedy. As head of the shop he must have a firm disposition, be prepared to meet emergencies, have the good will of the foremen and men under him, and be tactful so as to be able to straighten out the many little difficulties that are continually arising; it is far better if he has no relatives or friends working for him as it will save lots of trouble from fancied discrimination, etc. He must be an organizer in the true sense of the word and every move he makes must be in the direction of increasing his output and decreasing the cost. He should not allow work to be done carelessly or improperly; it takes a long time to build up a reputation for thoroughness which can be shattered in a few weeks if work is slighted."

The work of a railway shop consists largely of repairs, and in such cases the question of time is generally most important, and it is in the saving of time that effective organization makes itself felt.

"When an engine comes into the shop for repairs, it should be the duty of one or more men to inspect it, and immediately order all of the new material required, and see that it is placed at the machines or benches ready to be worked on when its time comes—don't wait two or three days after the engine arrives, and then find you want something that isn't in stock but ought to be; it will probably mean a delay to engine going out, which might have been

prevented if an earlier inspection had been made.

"In dissembling engines each part should be plainly marked so that when wanted again there will be no difficulty in finding it. The storage of parts that need no repairs is a matter worthy of attention. Much material is lost through neglect in storing it away where it cannot readily be found when wanted.

"To get engines or work out of a shop, there should be a classification of repairs, and each piece of work done, or each engine passing through the shops, should have a schedule of time, so that all concerned know when it will be necessary for the various parts to be ready. Don't do things haphazard. Set a time limit and work to it, making such improvement in tools, ways and means of doing work, etc., so that all lost motion is taken up and the results you are after, obtained.

"The head of the shop should have good men under him as foremen, all of them knowing their business thoroughly and at the same time being able to handle men with consideration, firmness and fair dealing; these combinations are frequently hard to get, but with a large force of men to pick from, the right kind of men can be found, who, by a little training, will meet the above requirements and soon get into his way of doing business."

An important element in the effective conduct of work is the knowledge by all of the results which it is desired to accomplish. Each man has his own definite task set before him, but it will help matters very materially to have the foremen know in a general way what is to be accomplished, and in turn they may be able to keep the superintendent in touch with details of which he might otherwise have only a general idea.

"The organization of shop forces does not end with the getting together of good foremen and men; it is also necessary to have such a systematic arrangement of accounts and reports that you will not only see that the men are getting the work out promptly, but can tell at a glance how much is being done and what it is costing. Without this knowledge you are not able to perfect the organization to its fullest extent. It also enables you to say when asking for new tools, what can be saved in time and money by their introduction, and to know whether it will be cheaper and better to purchase supplies, taps, reamers, etc., or make them in the shops.

"The superintendent of motive power who visits his shop frequently and knows all his foremen, can get better results and have the men feel more kindly disposed towards him than the one who does all his visiting by long distance telephone. A word of encouragement and a suggestion will often bring out latent ideas that otherwise might have lain dormant. It is natural for most men to like their superiors in position to come in personal contact with them and see what they are doing and whether advantageously or not, hence, the advisability of the superintendent of motive power or his assistant making frequent visits to the most important shops and keeping in close touch with the shop superintendents and foremen."

Among the important things in connection with the effective administration of a shop is the general foresight necessary to be prepared for emergency work, this involving a watch over the stock of material and reserve power which may be needed, and for the lack of which serious delays may be caused.

"The motive power department organization can be demoralized and nearly put out of business if it is not backed up by the storekeeper and accounting departments. The prompt furnishing of material in sufficient quantities to keep machines going long enough to perform the work economically is a matter that must have attention, otherwise the cost will immediately go up. The setting up of some machines often takes longer than to do the work, if furnished in small amounts, and a direct loss to the company takes place. The furnishing of cost sheets within reasonable time after the work is done is very helpful in detecting increased or decreased cost and applying the remedy in the former case before the matter gets old. In some shops messengers are used to deliver material and they are great time savers when used in connection with a shop telephone system. The ordering of material is done by 'phone to storehouse and deliveries are made from there by boys or men, thus ob-

viating the necessity of high priced mechanics going back and forth doing work that is just as well performed by cheaper labor."

In general the elements of good shop organization may be summed as including a good man at the head of the works, good men under him, a continual education of foremen and men, and proper control of men by foremen. With these should exist the essential elements of punctuality, orderliness, system, and harmony, together with prompt movement of material to and from the various departments, a good system of handling tools, and an effective use of templets and jigs wherever possible. So far as labor troubles are concerned, these may nearly always be avoided by an absolutely fair and considerate treatment of foremen and men.

SUBMARINE SIGNALLING.

PRACTICAL EXPERIENCE WITH THE MICROPHONE IN THE TRANSMISSION OF SIGNALS UNDER WATER.

The Engineer.

COMMUNICATION at sea by means of signals of various kinds has long been the subject of scientific study, and the importance of the question naturally causes all departments of applied science to be drawn upon to aid in its solution. Visual signals are employed wherever possible, both by day or by night, while the fog horn and the siren represent the efforts which, until recently, covered the application of audible signal systems. A number of years ago it was suggested that the thermo-pile might be employed to indicate, by the rise in temperature, the approach of a vessel, but so far as we are aware no practical application has ever been made of the suggestion. Recently the microphone has been used with much success to enable signals to be heard through bodies of water, and the practical development of this method has been such that it has been made the subject of experiments by the Corporation of Trinity House to determine its applicability for use in the British service. The whole subject, including the recent investigations of Trinity House, is discussed in a paper in a recent issue of the *Engineer*, from which we make some abstracts.

"The idea of passing sound signals through water is by no means new, and the advantages attending the transmission of sound by this method have long been known.

"As early as 1821 M. Colladon conducted experiments on the Lake of Geneva to test the suitability of water as a medium for transmission. He found that subaqueous sounds were totally reflected at the surface at such angles as rendered it impossible to hear them above water except for very short distances. By means of an instrument designed for listening below the surface, M. Colladon claimed to be successful in conveying distinctly audible sounds through water for a distance of 21¾ miles.

"It is well known that the rate of propagation of sound waves in water is over four times as great as the rate in air, and that an aqueous medium does not present the serious difficulties of interferences, shadows, and strata of varying density met with in atmospheric signalling. It sometimes happens that the most powerful atmospheric fog signals are inaudible to the mariner at distances of only a few hundred yards from the shore."

Researches upon the applicability of improved methods of submarine signalling have been conducted in Europe and in America for a number of years, and prominent among the investigators may be named Professor Blake, of Kansas City, Mr. A. J. Mundy, of Boston, the late Professor Elisha Gray, and others. To Professor Blake is due the valuable idea of using the hull of the vessel itself as the main receiving instrument for the sound signal, and this suggestion has been a fertile one. By placing a microphone within a tank containing liquid and attached to the ship's plating on its inner face, a receiver is obtained, which, with certain modifications, has proved very successful.

"The chief difficulty experienced in de-

vising an apparatus for transmitting and receiving the signals on board ship lay in the presence of local sounds, of more or less magnitude, in the ship itself. Experiments carried out on the steamers running between New York and Boston in conjunction with four of the light-vessels situated between these ports, proved that, if the tanks containing the microphones were filled with a liquid having a greater density than water and placed in suitable positions against the hull of the vessel, and the transmitters regulated to the recognition of vibrations of high frequency and not those of low pitch, external sounds, such as bell signals and the noises from screws of passing steamers transmitted subaqueously, were distinctly audible, while internal noises were practically eliminated, the latter becoming dissipated in the form of hull vibrations and failing to penetrate the insulating medium in the tanks. On the other hand, with transmitters attached direct to the ship's skin, the local vibrations completely swamped those due to external sounds."

The general construction of the apparatus is as follows: The microphone is placed in a water-tight case enclosed in a small cast-iron tank, bolted to the inside of the hull, the skin of the vessel forming the outer side of the tank. The microphone is adjusted to receive notes of short wave length only, this eliminating to a great extent the disturbing noises of lower pitches, while the high vibrations of the transmitting bell are readily received. The tank is filled with a super-saturated solution of brine, except in instances where temperatures below freezing are anticipated, in which case a special solution of high density and low freezing point is employed. Such a receiver is fitted below the water line on each side of the ship near the bow, each receiver being connected to a telephone on the indicator board in the chart room.

The transmitter is a small bell, of special design, tuned to emit a high pitch note, the clapper being operated by compressed air through a piston and connecting rod. The entire mechanism is enclosed in a chamber of phosphor bronze, with the bell attached below, so that the whole can readily be lowered over the side and submerged to a point well beneath the level of the keel of the light ship or other vessel sending the signals. The intervals of the signals may be controlled or regulated as may be desired, to enable the source to be identified, and a spare bell can be lowered in a few minutes if necessary.

"Continuous trials, extending over ten days, have been made with a submerged lightship bell and pneumatic actuating mechanism, without involving the necessity of raising the instrument for examination.

"It is noteworthy that the audibility of the bell is not materially affected by the position assumed by the instrument under water. Even if the bell and its attachments are deflected from the vertical by currents to a considerable extent, the efficiency of the instrument is in no way impaired.

"Bells have also been installed in isolated position at considerable distances from a lighthouse or light-vessel. One such, near the entrance to the channel leading to Boston Harbour, has been in successful operation for over twelve months. The bell is suspended from a submerged iron tripod, placed on the sea bottom in thirteen fathoms of water, at a distance 2½ miles from the shore near Point Allerton, and immediately opposite the Boston lighthouse. In place of the pneumatic actuating gear, a system of electro-magnets is installed, which actuates the clapper. The current is conveyed to the apparatus by cable a distance of over 2½ miles. The entire installation was laid and set to work in one day.

"In regard to the range of audibility of the bells, it is found that a small bell, weighing 140 lb., as now fitted, has been heard at a distance of 16 nautical miles. The range of audibility is largely dependent upon the size and draught of the vessel receiving the signal and the depth of the transmitters below the water-line. A large vessel, such as the Kaiser Wilhelm der II., exposes a very considerable area of ship's hull to the sound waves, with corresponding increment in effect. The signals given by a submarine bell can be frequently heard at distances of two to three miles, without the aid of microphones and receivers by merely placing the ear against some portion of the ship's plating

below the water-line. The intensity of the sound is found to be at its maximum when the direction of the bell is about abeam. With the bell straight ahead, the volume of sound is very much reduced, more especially in the case of fine-lined ships. Immediately the vessel deviates from the direction of the bell the intensity is largely increased. These facts were very clearly demonstrated on the occasion of the Trinity House trials on August 12th. It was found that the sound of the light-vessel bell could be heard at moderate distances by an observer stationed in the lower parts of the yacht Irene, and without the use of the instrument. The apparatus was tested at a distance of three miles from the North Goodwin lightship, and again at distances up to five miles, the bell being so distinctly audible at the latter distance that it was evident the limit of range had not been reached. With vessels of the size of a large Atlantic liner the signal should be distinctly heard at a distance of eight miles.

"Among the light-vessels already fitted with bell-ringing apparatus are twelve on the Atlantic coast of the United States between Portland and the Delaware River, four by the Canadian Government on the St. Lawrence or near the mouth of that river, and in Germany the Garbelsflach, which is the outer lightship at Kiel Harbour, the Outer Weser, and the Outer Elbe. The Canadian Government have recently approved a scheme embracing the equipment of twenty-six additional lightship and other stations with submerged bell signals.

"Among the ships fitted with transmitting apparatus are the Kaiser Wilhelm der II., Kaiser Wilhelm der Grosse, Kronprinz Wilhelm, Deutschland, the Lucania, and other vessels of the Cunard and Canadian Pacific lines. The Oceanic and one other vessel of the White Star line are about to be fitted with installations.

"As an instance of the sensitiveness of the microphone apparatus to external sound waves, it is interesting to note that the Deutschland, in June of this year, on nearing Dover Harbour, heard the sound of the divers at work on the national harbour works, and also the beat of the screws of a steamer at a distance of three miles."

HYDRAULIC POWER FROM THE WELLAND CANAL.

POSSIBILITIES OF THE UTILIZATION OF THE DIFFERENCE IN LEVEL BETWEEN LAKE ERIE AND LAKE ONTARIO AT THE WELLAND CANAL.

Alton D. Adams—Electrical Review.

NEARLY all the discussions of the power possibilities of the discharge of the Great Lakes assume that the power generating installations must be placed at or near Niagara Falls, regardless of the fact that the potential energy exists, not by reason of the falls, but because of the difference in level between Lake Ontario and the upper lakes of the chain. Only a portion of this difference in level between Lake Erie and Lake Ontario exists at Niagara Falls, more than one-half being taken up by the upper and lower rapids of the Niagara river, so that a channel or cut-off around the falls would enable a greater amount of power to be developed than is available directly at the cataract. Such a channel already exists in the form of the Welland canal, and the power-generating possibilities of the canal are discussed in a paper by Mr. Alton D. Adams in a recent issue of the *Electrical Review*, from which some of the salient features are here given.

"Welland canal parallels Niagara river in general direction, and connects lakes Erie and Ontario across the strip of Canadian territory about thirty miles wide that lies between them. The canal taps Lake Erie at two points, Port Maitland and Port Colborne, and joins Lake Ontario at Port Dalhousie. Port Colborne is about twenty miles up the Canadian shore of Lake Erie from the head of the Niagara river at Buffalo, but owing to changes in the direction of that stream, Welland canal runs only about eight miles from Niagara Falls. From Lake Erie to Lake Ontario Welland canal drops 327 feet, or from elevation 573 feet on Lake Erie to elevation 246 feet above tide water on Lake Ontario. All save about thirty feet of this fall along the

canal takes place between Lake Erie and the foot of the escarpment, where the high Niagara plateau breaks down to the low Ontario plain. From the brow of the escarpment to the Ontario plain at its foot the drop in elevation is as much as 270 feet at numerous points.

"By conducting the water of the upper Welland canal to the brow of the escarpment, which runs nearly parallel with the shore of Lake Ontario, it is thus practicable to maintain a head of water for power purposes that is nearly twice as great as the height of Niagara falls. If Welland canal had its summit level above the surface of Lake Erie, so that only a very limited supply of water could be obtained, the present great opportunity for the development of electric power would not exist. But the summit level of the Welland canal is at its Lake Erie parts, and the supply of water is limited only by what may be drawn from the four upper Great Lakes. The heads of Welland canal on Lake Erie have their mean elevations of 573 feet above tide-water level, and about 327 feet above the surface of Lake Ontario. From Lake Erie the surface of the canal falls slowly to the head lock near Allanburg, Township of Tharold, County of Welland, where its water stands about 325 feet above the Ontario level. This head lock is the highest of the series through which the Welland canal drops to Lake Ontario."

By tapping the Welland canal above the head of the lock near the Niagara escarpment a short canal and pipe line would enable the water to be discharged at a point at the foot of the escarpment nearly at the level of Lake Ontario. Such an undertaking would enable Niagara Falls to be "short-circuited" so to speak, and permit almost any amount of water to be drawn from the upper lakes for power purposes regardless of endeavors to preserve the scenic beauty of the great cataract.

The cost of the construction of the canal and pipe lines and penstocks would be small in comparison with the expensive tunnel and other works which have been incurred at Niagara Falls, but Mr. Adams calls attention to the fact that a reservoir would also be necessary in order to provide for the fluctuations of level in Lake Erie.

"Such storage is readily provided for by leading a comparatively short feeder canal from above the head lock on the Welland canal to a reservoir near the brow of the escarpment, above the point where a generating station is to be located. From a reservoir thus located penstocks may be run down the face of the escarpment to a power-house at its foot. In this way a water head as great as 270 feet on the wheels may readily be obtained. Under this head one cubic foot of water per second develops almost exactly three gross horse-power."

Mr. Adams describes at length the installations which have already been made to use hydraulic power from the Welland canal, especially in connection with the industries of the city of Hamilton. The plant of the Hamilton Cataract Power, Light, and Traction Company is operated by water diverted from the Welland canal at Allanburg, this being operated in connection with a storage reservoir system, and taking 700 cubic feet of water per second from the canal and delivering it to turbines under a head of 268 feet. At the present time this plant has a capacity of 24,300 horse power, with provision for increase to 38,500 horse power, the electrical energy being transmitted thirty-five miles to Hamilton, at 22,500 and 45,000 volts.

"Aside from competition for the markets of Hamilton and Toronto, which promises to be active, it is very probable that smaller cities and towns of Ontario will want their share of electric water power, and Welland canal offers the cheapest means of its development. It is to be remembered too that the amount of electric power which may be consumed in manufacturing industries is not limited by the population in a given territory, as is the case with lighting service. Thus an electrochemical plant that employs less than one hundred men may consume electric energy at the rate of scores of thousands of horse-power.

"New power plants about Niagara Falls must encounter increasing costs and difficulties of construction, as the best locations are already occupied. Along Welland canal and the Niagara escarpment, however, there are numerous opportunities for the diversion of water and the location of generating stations.

"Several new plans are now understood to be under way for the construction of plants that will operate with water from the Welland canal. According to one of these plans, for which surveys have been completed, a power-house is to be located at the foot of the escarpment several miles from St. Catharines, and the water supply is to come from the Welland canal through a short power canal and a large reservoir. From this power plant it is said that transmission lines will extend to Hamilton, Toronto and many smaller places. It would perhaps be unsafe to predict a limit to the diversion of water from Welland canal for power purposes, other than the physical capacity of that canal to deliver water near its head lock. The rate at which water will flow along the Welland canal from Lake Erie to free outlets near the head lock depends, of course, on the cross-section and slope of the canal, and on the nature of its bed. It is quite possible also that this bed would not withstand the eroding action that would follow a constant discharge at the maximum obtainable velocity in the canal. Whatever water rights are granted on the canal, the use of sufficient water for all purposes of navigation will no doubt be reserved. All water drawn from the Welland canal must, of course, come from the upper Great Lakes, and lessens by just so much the volume that passes over Niagara falls. Whether the Welland canal has a sufficient discharge capacity to materially reduce the supply of water at the wheel-pits, tunnels, power canals and pipe lines between the upper and lower river at Niagara Falls remains to be determined."

STEEL DAM CONSTRUCTION.

A DISCUSSION OF THE COMPARATIVE ADVANTAGES OF STEEL AND MASONRY FOR THE CONSTRUCTION OF DAMS.

F. H. Bainbridge—Western Society of Engineers.

THE recent discussions as to the stability of masonry dams, already noticed in these columns, are attracting renewed attention to the desirability of employing structural steel, either in connection with concrete or alone as a desirable method of construction.

The uncertainty which exists as to the real stability of masonry structures, together with their high cost when large dams are required, give the subject both a technical and a commercial interest, so that the investigations now being made into the theory of masonry dams may result in the abandonment of masonry altogether, in favor of forms of construction of a more determinate character. The use of masonry limits the engineer to types in which no tensile stresses are permissible, and while the problem is capable of complete solution when certain conditions are observed, actual practice demands that all the conditions in existence shall be met. In many cases, however, the actual conditions cannot be completely ascertained beforehand, and the extent to which the artificial structure can be bedded in the rock of the foundation, together with the manner in which shearing stresses are resisted, renders it difficult to insure in the actual structure the conditions upon which the computations were based. For these and other reasons engineers are turning to steel as a material for dams, realizing that they have then to deal with a material capable of resisting tension, and in which the direction and concentration of stresses can be more positively controlled, and there are numerous reasons for believing that steel dams will be used hereafter for numerous important installations.

In a paper recently presented before the Western Society of Engineers by Mr. F. H. Bainbridge the construction of steel dams is considered, and the practical information contained in this discussion renders it of immediate value and interest.

About twelve years ago, when Mr. Bainbridge first examined the subject of steel dam construction the price of structural steel was as low as 1 cent per pound in Pittsburg, while at the present time prices are about 75 per cent. greater. At the same time the price of Portland cement has fallen to about one-third what it was in 1894, but in spite of the changes in prices

a great economy will be found in the use of steel in many locations.

"For average conditions in the western part of the United States the section of a masonry dam may be taken as equivalent in quantity to a section 8 feet wide at the top and with a base of five-eighths the height. This gives for a dam 100 feet in height an average of 1.3 cubic yards of masonry or concrete per square feet of cross section, which at $8 per cubic yard, gives $10.40 per square foot of cross section. The weight of steel per square foot of cross section will generally be found to be about 1.25 times the height of the section, or 125 pounds for a height of 100 feet, and at 4½ cents per pound erected and painted, there will be a cost of $5.62 per square foot of cross section.

"Again it will be found that in most locations in our Western country where favorable sites for dams exist, a considerable haul by team from the nearest railway is necessary. Considering a cross section 100 feet in height, and assuming 0.8 of a barrel of Portland cement to the cubic yard of rubble masonry, the weight of cement to be hauled will be 400 x 0.8 x 1.3 = 416 pounds per square foot of cross section, as against 125 pounds of steel. It is assumed, in this comparison, that suitable sand and stone will be found at the site, which is seldom the case. For concrete the comparison is still more favorable to the steel.

"It is usually assumed by the uninformed that stone structures subject to the action of air, water, and frost will last indefinitely. As a matter of fact only a small percentage of the stone which is accessible is at all fit for use in structures, and even in the best quarries, the inferior stone which must be wasted or used for riprap, often amounts to 50 per cent. or more of the stone quarried. In a dam, especially in cold climates, stone is subjected to most trying conditions and untried local stone should be used only with the greatest caution.

"So far as present experience goes Portland cement concrete for dams appears to be a safer material, but it must be remembered that concrete setting in air contracts in volume, and in large masses cracks are almost certain to result. For this reason concrete for large dams must first be cast in blocks and set in mortar joints after being dried out. Under certain conditions reinforced concrete for high dams appears to be a promising material, especially where an arched form is permissible, and its first use in this direction will be awaited with considerable interest. A number of low dams have been built of reinforced concrete, but as questions of economy limit the use of steel to high dams, such only are here considered.

"While stonework, in common acceptance, has an undeserved reputation for permanence and stability, steel has an equally undeserved reputation for deterioration. The reason for this is plain. Opportunities for observing the weathering of steel are most frequent in large cities where the air is laden with sulphuric and carbonic acid gases. Iron, water, rust, is usually looked upon as a necessary sequence, but observations on stand-pipes and dams built of steel show that reasonably pure water alone has little effect in corroding steel, and that under water a good paint is a first-class protection."

Mr. Bainbridge describes the 42 feet high steel dam at Ash Fork, Arizona, which was completed in 1898, and which, with a careful painting with oil, red lead, and graphite paint at the time of erection showed no indication of rust after four years. As this is believed to be the first fixed metallic dam ever constructed some details will be of interest.

"The steel portion of the dam is 184 feet long on top and the whole dam is about 300 feet in length, including short masonry abutments at each end. Structurally it consists of a series of triangular steel bents resting on concrete foundations and carrying steel face plates on the inclined or upstream end. No spillway or waste weir is provided, the dam being designed to permit a flow of 6 feet depth of water over the crest. Since its construction a maximum flow of 4 feet has been observed. To prevent the overflow from undermining the foundations, loose rock is piled at the base to break the force of the falling water. However, overflow to any considerable extent is a matter of rare occurrence.

"The structure is composed of alternate

rigid and loose panels. The crest or apron plates which fit the braced panels between the bents are riveted to a curved angle which is riveted to the upper end of the curved plate, while in the unbraced panel this angle merely bears on the apron plate. By this means the forces which would result from longitudinal expansion and contraction and which would be fatal to the structure are avoided. The face of the dam is composed of steel plates ⅜-inch thick and 8 feet 10⅝-inches wide, riveted to the outer flanges of the inclined I-beams of the bents. The plates are mainly 8 feet in length, curved to a radius of 7 feet 6 inches, forming a series of gullies or channels down the face and leaving a flat portion which rests on and is riveted to the I-beams. The curved plates, however, do not extend into the concrete of the toe, but are replaced by flat plates in the bottom course, the bottom plates being dished."

The steel dam with concrete foundations, built at Redridge, Michigan, was completed in 1901, and has been in satisfactory service ever since, and in addition to these two existing examples Mr. Bainbridge describes a typical bent for a 100 foot steel dam, showing the bracing and distribution of the stresses.

SIMPLON-TUNNEL CONNECTIONS.

THE COMPLETION OF THE SIMPLON TUNNEL AND THE RELATION OF ITS CONNECTIONS TO THE RAILWAYS OF FRANCE.

La Revue Technique—Schweizerische Bauzeitung.

THE announcement of the junction of the headings of the Simplon tunnel in February last by no means indicated that the great work was wholly completed. Since that date, however, steady progress has been made, and the questions of the best railway connections to enable the full benefit of the new passage through the Alps is again being agitated. In recent issues of the *Schweizerische Bauzeitung* the details of the completion of the actual tunnel are recorded, while a review in *La Revue Technique* continues the discussion of the French railway connections to the new route to Italy and the East.

Dr. M. Rosenmund, writing in the *Schweizerische Bauzeitung*, discusses the accuracy with which the alignment of the tunnel was verified by the completed work. Notwithstanding the fact that the tunnel was longer than any which has yet been undertaken, and that its construction was attended with many unforeseen difficulties, the junction of the headings revealed a high degree of precision in the work. The first determinations of the lines of the tunnel after the opening of communication showed a difference of only 9 centimetres between the two levels, or about 3½ inches, while the lateral deviation was found to be 5 centimetres, or less than 2 inches. Later measurements confirmed the accuracy of the vertical alignment, but more careful examination, after the mist arising from the hot springs had been removed by forced ventilation showed a slightly greater error in the lateral direction, the lines passing each other by about 9 inches in the middle of the tunnel.

So far as the actual length is concerned the measured length between base points was found to be 0.79 metre less than that computed for triangulation, this being in a length of nearly 20,000 metres, or 31 inches in twelve and a quarter miles.

The present state of the work on the tunnel gives assurance that it will be ready for service by the beginning of 1906, and it is this fact which forms the keynote of the paper in *La Revue Technique* by M. Paul Olivier Lacroye. Something must be done if the commerce of France is to profit by the opening of the new route, and the time in which to do it has already arrived. The Swiss connection of the tunnel is the Simplon-Jura Railway, which skirts the northern bank of the lake of Geneva, passing through Lausanne to Geneva, and provided thence with connections to the Paris-Lyons-Mediterranean Railway, but this is but an indirect communication to the north, and unable to compete with existing routes, so that a better and shorter, and more direct communication must be provided if the course of traffic is to be diverted.

Broadly there are two viewpoints from

which the Simplon connection can be regarded. Of these one considers only the desirability of providing a direct communication from the tunnel to Paris and to the North Sea ports, while the other includes a realization of the fact that Paris is not everything, and that it is important to provide a direct trunk route across France at its narrowest part and provide direct communication with the Atlantic.

As a consequence of these two independent ideas there are two plans for connection with the Simplon which are under consideration, one of these being known as the Frasne-Vallorbes line, and the other the line of the Faucille. The first of these includes communication with Paris and with the North Sea ports, and it has been proposed as a substitute for the so-called Pontarlier route, which already exists, but which is subject to the objections of high altitude, difficult curves, and frequent interruptions by reason of snow. By the construction of the short connection between Vallorbe and Frasnier the line from Milan to Paris by the Simplon is reduced to a distance of 830 kilometres. It is true that various objections to this plan have been advanced, and it is evident that the connection would be improved by extending the new line from Frasne to Joux, thus reducing the grades and curves. One of the principal recommendations of the plan is its moderate cost, the share of Switzerland being 7,000,000 to 8,000,000 francs, and that of France about 20,000,000 francs.

The other plan, that of the route by the Col de la Faucille, ignores Paris, and is based upon the importance of making a direct connection between Italy and the Atlantic by way of the Simplon, thus forming a trunk line across France. This route, it is true, involves the boring of another tunnel and the construction of some difficult work, but it would provide France with a line which could not fail to increase her commercial importance. By giving a direct route from Italy and the East to the Atlantic, including access to a port such as that of St. Nazaire, it would enable France to compete with Germany as regards transatlantic service, and effect a transformation in much of the commerce between Europe and America.

The line by Frasne-Vallorbes is all right for communication between Italy, France, and England, but this is a route already well served. If France is fully aroused to her opportunity she cannot fail to realize that the great opportunity before her is to leave Germany upon one side and to provide a through route from the east, via the Simplon tunnel, to the Atlantic, and to use the Atlantic terminus as the port for a first-class steamship line, either that which now runs from Havre, or an entirely new line from St. Nazaire to compete effectively with the German lines, and, in connection with the trunk railway line across France, to control a great portion of the commerce which now goes by other routes.

DUST PREVENTION ON HIGHWAYS.

IMPROVED METHODS OF DESIGN FOR MINIMISING THE DUST-RAISING ACTION OF AUTOMOBILE VEHICLES.

W. R. Cooper—Nature.

DUST has always been more or less of a nuisance in connection with highway travel, especially in dry weather, but the problem of dust prevention has been so emphasised by the introduction of the high-speed automobile that it is demanding the best skill of the engineer to devise means which shall be both effective and commercially practicable. A review of the methods which have thus far been considered, together with an account of experimental researches into the phenomena of dust raising is given in a paper published in a recent issue of *Nature* by Mr. W. R. Cooper.

"At the present time by far the most serious problem which the automobilist has to face is the abatement of the dust nuisance. A great deal of bad feeling has arisen against the motorist on account of the dust which he too frequently produces, and there is no doubt that there are very good grounds for the irritation which has arisen, more particularly in agricultural

districts. Farming in England, at the best of times, is not in a prosperous condition, and a farmer does not view with any kindly eye a further reduction in his produce through the effects of dust. Apart from that, however, dust may cause a great deal of personal discomfort to other users of the roads; but this phase of the question would, perhaps, not require very serious consideration were it not that dust of this nature is apt to carry disease, and to lower the health of the poorer part of our population living along the main thoroughfares. As such matters may lead to serious opposition to automobilism, and possibly to further legal restrictions, all tending to hamper a growing and very important industry in this country, it is becoming imperative to see what can be done to minimise a nuisance of this kind.

"At present there are two distinct methods of tackling the problem. On is to treat the roads, or construct them, in some way so that they no longer give rise to dust. The other is to so alter the construction of the car that dust, if it exists, will not be raised to a serious extent."

The question of the treatment of the roads has been under practical consideration for a long time, and the ordinary watering cart is doubtless the earliest example of this department of the work. The effect of the water is but temporary, however, and when the water is used in excess, as is usually the case, the result is injurious to the road. Other materials than water have been tried, deliquescent salts being suggested, while a certain measure of success has been attained by treating the surface of the road with oil. Mixtures of petroleum and ammonia have been used with some success, while in California the treatment of the roads with crude petroleum has been very effective in preventing the formation of dust. The nature of the oil employed seems to have a material influence upon the success of the operation, and it is necessary that the petroleum and the road material should bind together to form a tough and strong surfacing. This probably explains the non-success, or only partial success which has attended attempts at oiling roads in Great Britain. A similar experience is had with the use of tar. A permanent result can only be obtained by the formation of a waterproof crust to a fair depth, so that the dust forming materials cannot work up, and this can be obtained only by combining the tar with the materials used in the construction of the road.

Such a material as granite or syenite can be improved only temporarily by the application of tar, the coating rapidly wearing off. A surfacing of porous furnace slag and tar is found to give a good dustless road, the broken slag being thrown into the tar while hot, and the pores becoming so thoroughly impregnated as to render the material a dustless surfacing.

All methods of treating the surfaces of the road are necessarily limited in scope, owing to considerations of cost and time, and while the roads within and adjacent to towns and villages may be thus improved it is impracticable to give the same attention to the extended country routes so extensively used in touring.

Attention has more recently been directed to the fact that it is possible to minimise very greatly the production of dust by modifications in the design and construction of the car, and this opens a fertile field for investigation and study. In many instances the alteration of some trifling detail has resulted in great improvement, such, for example, as the change of direction of a downward pointed exhaust to a position in which it will not stir up the dust.

"Speaking generally, and leaving such special points as direction of exhaust out of account, it may be said that the dust is raised by the tyres, and is then scattered by the air currents produced by the body. In other words, if the body were moved along the road at its normal height, supported by other means than the wheels, very little dust would result. But it is equally true that if the wheels could be run without the body there would not be much cause for complaint as to dust. By *body* is here meant the whole structure, apart from the wheels, so that the term is more comprehensive than usual. The passage of a car body through the air necessarily creates a great deal of disturbance, and the extent to which the air near the ground is disturbed must depend to a great extent upon the shape of the body. The

less the disturbance, the less will the dust be formed into a cloud.

"In 1903, the Automobile Club tested the dust-raising qualities of a large number of cars. Each car was run at twenty miles per hour over a patch of flour on the cycle track at the Crystal Palace. The flour was kept at a definite thickness, and as each car passed it was photographed. These photographs gave a permanent record of the dust cloud raised by each car, enabling the committee to classify the cars in the order of merit. The records so obtained gave a great deal of useful information, and it was recognised that this method of testing was far more satisfactory than optical observations, because an observer has a good deal of difficulty in retaining a mental picture of what may be termed a standard car as regards dust.

"In a paper read in 1903 before the Automobile Club, Colonel Crompton and Mr. Crawley came to the following conclusions, based on these experiments:—Hard tyres are better than soft; narrow tyres are better than broad; neither have a preponderating influence; flaring mud-guards are probably bad, especially if they come low down; cars which are low underneath are worse than cars a long way off the ground; but smoothness of bottom-shape and absence of forward-coning are infinitely more important. There is strong evidence that it is desirable that the car should slope upwards towards the back. At the same time, the authors point out that a low car is not necessarily a dusty one, nor is a high car necessarily dustless."

Preconceived ideas with regard to the production of dust are not entirely borne out by the results of experiments, and in Mr. Cooper's article there are given a number of photographs which are much more valuable than any general theorising about the subject of dust raising. In order to eliminate extraneous elements, Mr. Cooper constructed a special apparatus, consisting of a form of tricycle, with two small leading wheels, and a single trailing wheel of ordinary bicycle type, the whole having a light skeleton frame, this vehicle being arranged to be drawn at speeds of fifteen to twenty miles an hour over a track laid with flour.

By attaching various fixtures to the vehicle it has been possible to photograph the effect of distance from the ground of the lower portions of a car, while screens, inclined planes, and similar attachments may have their effects recorded. The influence of hard and soft tyres has also been studied, and a foundation laid for a scientific study of the whole problem.

"Although, from the point of view of raising dust, the tyres may not be so important as the body, their action does seem to be important enough to warrant more careful investigation. They are capable, in themselves, of raising a good deal of dust, as is often to be seen in the case of bicycles. Very possibly dust is carried up by tyres through a kind of suction, and this may vary a good deal with the design. Now that there are so many different tyres, including non-skidding bands, on the market, there is likely to be a considerable difference in the various types as regards dust. In the photographs which are reproduced, the wheel is equivalent to the front wheels of a car, as there is no driving force on the tyre. In the case of wheels which are drivers, there will be a certain amount of slip of one kind or another, and the dust raised is likely to be greater; but, actually, there does not seem to be any very great difference between drivers and non-drivers—at least there is much less than would be expected."

In general the influence of the body of an automobile upon the raising of dust appears to be determined partly by the presence of irregularities beneath. An inclined plane, so placed as to direct the air severely down upon the track, did not appear to produce as much dust as might have been expected, while a square box placed at 9 inches above the surface of the road raised a noticeable amount of dust, this corresponding somewhat to the tool box of an automobile, such boxes often being still closer to the ground.

An examination of the photographs in Mr. Cooper's paper indicates very clearly the possibilities which exist for improvement in design as regards dust raising properties, and for touring machines especially this is a feature which may well occupy the attention of the builders of automobiles as an important element in design and construction.

APPLICATIONS OF POWER GAS.

THE USE OF GASEOUS FUEL FOR THE GENERATION OF POWER AND THE PRODUCTION OF HEAT.

Ernest A. Dowson—Birmingham Association of Mechanical Engineers.

ALTHOUGH many papers and articles have been written of late upon the subject of gas power, most of these have been devoted either to the discussion of some especial form of generator or producer, or to descriptions of different kinds of gas engines.

A much broader treatment of the question appears in a paper recently presented before the Birmingham Association of Mechanical Engineers by Mr. Ernest A. Dowson, this being a general review of the use of gas for power and heating purposes, without advocating any special forms of appliances for the purpose.

Assuming that the gas engine has passed out of the experimental stage and that no apology is needed on its behalf, Mr. Dowson simply calls attention to the facts that not only is the thermal efficiency of the gas engine fully double that of a high-class steam engine, but that in practice the gain is far greater because only a few first-class steam engines of large size realize even good working efficiency. Any comparison between steam and gas power should include all the elements of the respective plants; the boiler, piping, engine, and auxiliaries, on the one hand, being compared with the producer and generating appliances, and the gas engine, on the other part. In such case the advantages of the gas plant will be seen to be even greater than appears by comparing the engine performances alone.

Omitting from consideration the vapors of liquid hydrocarbons, Mr. Dowson examines various kinds of power gas, these including ordinary illuminating gas, or, as it is sometimes called "town gas"; producer gas; water gas; and semi-water gas. Under the term producer gas is included not only the lean gas obtained by the partial combustion of fuel to carbon monoxide, but also the waste gases from blast furnaces, this being practically of the same composition and properties.

Plain water gas, formed by the interaction of steam and incandescent carbon, is a valuable fuel for heating furnaces and special purposes, the large percentage of hydrogen giving it a high flame temperature. It is, however, not well adapted for use in gas engines, since the excess of hydrogen causes a high rapidity of flame propogation, producing violent explosions and heavy shocks to the engine, while the use of the most advantageous compression is impracticable, owing to danger of preignition.

Excellent results are obtained with semi-water gas, this being practically a combination of producer gas and water gas, obtained by passing a mixture of air and superheated steam or even saturated steam through an incandescent bed of coal or coke. Such a gas contains 16 to 18 per cent. of hydrogen, instead of 50 per cent. as in straight water gas, together with about 25 per cent. of carbon monoxide.

"For making gas for driving engines, the *best* results have been obtained when the fuel is either small anthracite pea or ordinary gas coke, but latterly something has been done in the way of using ordinary hard, non-caking, bituminous coals, which in some districts are cheaper than the former. It must, however, be remembered that a mere comparison of the prices of the raw fuels per ton does not constitute a complete basis from which to compute the relative costs of a brake horse-power hour obtained in any given cases. Fuels other than the two first mentioned have certain drawbacks, especially in plants of average size. The removal of the tar which is found in gas made from any bituminous fuel requires more extensive cleaning apparatus, part of which generally needs engine power to drive it, while the water consumption is incresed for the same reason, in addition to which it is distinctly a dirty process. It is a mistake to suppose that *any* class of slack coal may be employed, even in large installations. All coalfields do not yield fuel which will give good results in gas making. Bituminous coals are not of so uniform a quality as

are those of the anthracite class, and they will always be more troublesome to deal with than are the latter. Some coals are very apt to hang up in the generators, which, besides causing troubles in working, inevitably leads to variations in the quality of the gas made. More labor is always involved in the gasification of bituminous fuels, and a certain element of risk is introduced of tar getting over to the engines on occasion. When this occurs much trouble is experienced by the gumming up of the valves and other working parts, causing serious delay and loss."

If bituminous fuel is to be used it is best to install a complete scrubbing and washing plant, in which case a by-product recovery system, such as devised by Dr. Mond, may be found profitable. Such plants, however, are better adapted for large central stations than for the individual user, and the smaller plants are best designed on the suction principle, the gas engine itself acting to draw the air and steam through the fuel.

"The fuel consumption is extremely low, as instanced by tests which have shewn a figure as low as .8 lbs. per brake horse-power per hour of small anthracite of commercial quality, such as can be obtained in Birmingham at about 18 shillings per ton. The water required for gas making and cooling does not exceed about 6 pints per hourly brake horse-power. Beyond this, an allowance for attendance must be made, and for a plant of, say 100 brake horse-power, the time required is about 2 hours daily for one man. The small space occupied is also an important feature, and this is, roughly, equal to about half a square foot for each brake horse-power capacity. Installations of this type of plant are at work where the power is utilized in driving dynamos, supplying current for both electric lighting and power, and the fact that the *whole station costs* have worked out at from ½d. to ¾d. per unit shows the really remarkable economy of the system."

Mr. Dowson reviews rapidly the construction of various types of gas engines as made in Great Britain and on the Continent, including both the four-cycle and the two-cycle types, referring especially to large engines for electric generating stations and iron works.

"It is well known that in all gas engines of large dimensions the greatest troubles experienced are those arising from the high flames temperature incidental to the explosion. Rapid cooling of the charge must therefore be resorted to in order to protect the working parts. The aggregate of the expansion of the metal forming the combustion chamber and cylinder becomes, in a large engine, a very appreciable amount. It is therefore extremely advisable to leave all this metal as free to expand as possible. This is, however, rather a difficult problem, as, taking the combustion chamber for instance, the inlet and exhaust ports, together with others for the ignition apparatus and the starting apparatus, must in any case be provided. For this reason valveless engines, such as the Oechelhäuser, are easier dealt with in this particular.

"Continental makers of large gas engines have gone in for great elaborations in the way of water cooling in order to get rid of these temperature difficulties. With great ingenuity they have arranged to water-cool the pistons and piston rods in the double-acting engines, in addition to the ordinary cylinder jacket. The exhaust valves and their casings are also ingeniously water jacketed in most of these engines. It need hardly be pointed out, however, that the many complicated devices thus needed introduce additional risks of failure, and it is reasonable to look upon them as a merely temporary endeavor to make a working engine of large power. In view of these facts it really appears to practical engineers that the best way of building such an engine is to replace the large single cylinder by several of moderate size, say three or four, each of which we know from experience is capable of being worked over long periods without any chance of breakdown."

The use of gas for heating purposes in manufacturing is extending continually and the advantages of such a clean, efficient and controllable fuel are incontestable. The late Sir William Siemens is quoted as saying: "I consider it perfectly barbarous to use coal for any purpose in its crude state, and believe the time will come when all crude fuel will be separated into its component parts before it reaches our habitations."

"As has already been insisted upon in connection with power plants, it is necessary to exercise a good deal of judgment in each case as it occurs, and this is even almost a stronger necessity where heating is required. In the first place, it is necessary to decide whether or not the installation of a gas plant *is justified* by all the circumstances. Obviously, if any given appliance, at present coal-fired, shows a very high thermal efficiency, one has hardly a prima facie case for recommending the change. Of course there may be other incidental reasons for deciding in the affirmative, such, for example, as increased convenience and cleanliness, reduced attendance, etc., and these last named are frequently very important. Even when one has decided on the change, open questions still remain, not only as to the make up of the gas plant, but also to the exact way in which the gas shall be applied to the work in view. The method that gives good results in one case will perhaps totally fail in another, and this has brought it about that in some instances failure to effect the hoped-for economy has led users to discard gas firing as a failure altogether. This need never occur if the normal working programme has been carefully considered from the outset, and the heating appliances properly designed."

Although water gas, from its high calorific power, is best for heavy welding purposes and special uses, semi-water gas is generally to be preferred because of its cheapness. By its use temperatures above 2,000 degrees F. can be obtained in a crucible furnace without using any air blast, employing the cold gas from a main, while much higher temperatures can be attained with a blast and superheated gas.

Mr. Dowson's paper contains much valuable information concerning costs and installation methods for gas plants, and forms a valuable contribution to the technical literature of an important department of engineering work.

APPLICATIONS OF SUPERHEATED STEAM.

DATA AND RESULTS OF RECENT EXPERIMENTS IN FRANCE UPON THE ECONOMY OF SUPERHEATED STEAM IN RECIPROCATING ENGINES.

Ch. Compère—Société des Ingénieurs Civils de France.

IN a recent communication made by M. Ch. Compère before the mechanical section of the *Société des Ingénieurs Civils de France*, and published in the *Mémoires* of the society, there is given a general review of recent progress in superheating, the information being largely drawn from French experiments of late date.

At the time of the Düsseldorf exhibition in 1902 M. Compère examined the performance of the steam engines there exhibited, and called attention at that time to the fact that superheating was much more widely used in Germany than in France, the consequent efficiency of such engines attaining a consumption of 4.49 kilogrammes, or 9.9 pounds, of steam per horse power per hour for an engine of 300 horse power, using steam superheated 300 degrees C. Although such results have been attained by engines under tests they are by no means common in everyday service, and M. Compère proceeds to examine the conditions which surround the use of superheated steam.

In the first place it must be remembered that the steam engine, as invented by Watt and as actually used at the present time, includes the engine, the boiler, and the communicating piping. This fact is often lost sight of since the specialization in construction has separated the manufacture of the several portions of the motive-power machine, and has led to their independent development.

It is for such reasons that we find, for instance, the builder of an engine guaranteeing a performance conditioned upon the delivery to the engine of steam of a certain pressure and degree of superheat; or, again, for efficiency guarantees to be given for the engine and boiler separately, without taking into account the losses which occur in a long line of pipe. For such reasons M. Compère emphasises the necessity of considering an installation as a whole in examining the practical performance of a plant using superheated steam.

In Germany it is common to use lift, or

poppet valves, and it is sometimes assumed that slide valves, either of plain or the Corliss type, are unsuited for use with superheated steam. In France the poppet valve is not often employed, both because of the greater clearance which it requires, and because it is generally believed to be less economical than the slide valve, although the recent experiments in England indicate that leakage losses from slide valves are more serious than has been generally supposed.

M. Compère gives in detail the results of several trials of engines in France with superheated steam, these being made upon engines fitted with Corliss valves. For the details of these trials reference must be made to the original paper, but the results may be given here, together with some of the conclusions drawn.

Thus, with a Corliss engine of 140 horse power, built by MM. Weyher & Richemond, of Pantin, arranged to be supplied with either saturated or superheated steam, operating at pressures of 6 to 7 kilogrammes per square centimetre (85 to 100 pounds per square inch) working with and without a steam jacket, the following results were obtained.

Operating with saturated steam, a consumption of 6.85 kilogrammes of steam (15.1 pounds) was required per horse power per hour, a very excellent performance for a single-cylinder engine of this size; the steam jacket being in use. With the steam superheated about 260 degrees C. this consumption was lowered to 5.865 kilogrammes (12.92 pounds), the jacket still being in use, while with the same degree of superheating, but without the jacket, the consumption was still further lowered to 5.68 kilogrammes (12.52 pounds).

This question of the influence of superheating upon the economy of jacketing has already been observed, but M. Compère examines it in an interesting manner, and shows the conditions under which jackets are or are not of advantage. The jacket acts as a transmitter of heat, and with saturated steam or with steam which is only slightly superheated the gain by transfer of heat to the cylinder is greater than the loss by transfer from the outside of the jacket to the atmosphere. With higher degrees of superheat, however, the external losses overbalance the internal gains, and it is more advantageous to keep the superheated steam up to its maximum temperature until it enters the cylinder, rather than to permit it to lose a portion of its heat in the jacket. By a graphical diagram based upon the experiments with the Weyher & Richemond engine M. Compère shows the relation which superheating bears to jacketing. Without a jacket the economy due to superheating appears at once, and the gain appears to follow nearly a straight-line law, the steam consumption falling almost in direct proportion to the increase in superheat, at least within the range of the experiments, which extended up to 270 degrees C. superheat. With the steam jacket, however, a large portion of the economy effected by early stages of superheating has already been secured, and there is practically no gain up to a superheat of about 210 degrees C. At this point, however, the two lines intersect, the curve showing the consumption without the jacket being below the jacket curve, and beyond a superheat of 230 degrees C. the two lines run nearly parallel, the economy of superheat without jacket running about 0.35 kilogramme, or 0.77 pound, of steam per horse power per hour better than with the jacket.

These observations compare favorably with those of M. Vanderstegen, except that the latter engineer fixed the point at which the jacket ceased to be of benefit at 250 degrees C., while M. Compère finds it to take place at the lower point of 210 degrees.

The question of the efficiency of superheated steam in jackets is closely allied to the subject of losses in pipe transmission.

The experimental investigations of Dr. Berner in Germany, as well as practical experience elsewhere, shows that much greater care is necessary in covering steam pipes and protecting against radiation losses with superheated than with ordinary saturated steam. The excess heat which is conveniently given to the steam is also readily lost and this applies to the steam pipes as well as to the jacket. M. Compère cites a case in which steam superheated to 320 degrees C. at the boiler lost 100 degrees in transmission through a distance of 46 metres, and it was found impracticable to maintain more than 200 to 220 degrees superheat at the engine. The

only available remedy was the removal of the boiler to a position close to the engine. This fact doubtless explains in part the high economy of the Wolf semi-portable engine, the cylinders being mounted directly upon the boiler and the steam passing directly from the superheater to the cylinder without opportunity of radiation losses.

M. Compère discusses the question of independently-fired superheaters as compared with superheaters placed in the boiler flue.

In general there is less gain in fuel by the use of the independently-fired superheater, but this is frequently made up by the greater facility of control and the lower repair expense. Practical advantages may be indicated for either type, but in everyday practice the independent superheater is found to possess material advantages. Care must be taken in the design of the independent superheater to utilize the heat to full advantage, and many designs permit the gases to escape at a higher temperature than is consistent with best superheater efficiency.

In order that the real benefits of superheating may be attained in actual practice it is necessary that the installation be considered on its merits and the details worked out for the local conditions. The whole plant must be taken into account, including boiler, connections, and engine, otherwise the gain in one portion may be neutralized by the losses in another. The influence of high temperatures upon tightness of joints and packings must not be overlooked, and the influence of the heat upon the valves considered, both as regards leakage and danger of sticking. Unless such precautions are taken it will be found that the undoubted advantages of superheating, as shown in scientific tests, will not be borne out in daily service, while with suitable exercise of judgment and care the gain may be fully realized.

CONCRETE BUILDING CONSTRUCTION.

EXTENDING APPLICATIONS OF HOLLOW CONCRETE BLOCKS FOR BUILDING AND ENGINEERING STRUCTURES.

S. B. Newberry—Cement.

THE increasing use of cement, either in the form of ordinary or reinforced concrete is one of the significant features in current engineering progress. Some small indication of the growth of these applications may be found from the bald statement of the fact that the production of cement in the United States has increased three-fold in the years from 1900 to 1905, and while this increase has been due to more than one cause there is no doubt that a large part of the demand has come from the extending applications of concrete in construction. An important element in the growth of concrete work is found in the use of various forms of concrete blocks, and this branch of the art forms the subject of a valuable issue of *Cement*, from which we make some abstracts.

"The cause of this remarkable development of a new material of construction is chiefly to be found in the rapidly failing supply of lumber, together with the widespread public interest in all applications of Portland cement. The advance of more than 50 per cent. in the price of lumber during the past few years has been a serious hardship and obstacle to the increasing multitude of people who aspire to having homes of their own, and it is but natural that builders should look about for some efficient substitute for wood, and should look with favor on a material which offers advantages of durability, safety, comfort and beauty which are unknown in frame construction.

"There is good reason to believe that this efficient substitute for wood has been found in the hollow concrete block, and that we are still only on the threshold of the development of this building material. Opposition to its use on the part of the consumer is not to be feared; the obstacles to be overcome lie chiefly in the danger of careless or ignorant work by blockmakers and builders, and in the need of study and invention to adapt the material to the economical production of convenient and beautiful structures. There is every reason why

concrete should become the chief building material of the future. For large and costly buildings it is likely that solid concrete, plain or reinforced, will have the preference. For smaller structures, especially factories and dwellings, hollow blocks are certainly cheaper, more suitable, and require much less technical skill in erection. The possibilities of this type of construction seem to be unlimited."

Mr. Newberry discusses briefly the history of hollow concrete blocks in construction, showing that although solid blocks were employed in the early part of the nineteenth century the advantages of the hollow form did not appear until much later. According to Mr. Newberry, the use of hollow concrete blocks, to be filled up with concrete after being placed in position, was patented by Sellars, in England, in 1875, but we believe that very large blocks of this kind were employed in the construction of the breakwater piers at the Port Said entrance of the Suez canal, several years before. However this may be, there is no doubt that the hollow block of concrete possesses many advantages, and that its development as a standard article of manufacture at a recent date has placed a most valuable material in the hands of the engineer and builder.

An essential element in the commercial manufacture of hollow concrete blocks is the modern block machine, the credit for which Mr. Newberry gives to Mr. H. S. Palmer, although there are numerous well-designed machines now on the market.

"Portland cement, owing to its uniformity, strength, and especially its promptness in hardening, is the only hydraulic material which finds any considerable use in block making. A great point in favor of Portland cement is that it gains at least as great strength in air as in water; other hydraulic cements are generally unsuitable for work not kept permanently wet. At the present moderate price of Portland it is certainly cheaper in use, for a given strength, than any of its substitutes.

"The aggregate, or inert coarse material used with cement to produce concrete for blocks, may be either sand and gravel or stone screenings. There is little choice between these two classes of material, if of good quality. Sand and gravel are generally cheaper, and are usually somewhat easier to perfectly mix with the cement. In the matter of strength and hardness of the resulting blocks there appears to be little or no difference.

"The strength of concrete depends greatly on the density of the mixture, and this is chiefly a question of voids in the aggregate used. It is well known that a mixture of cement and sand is weaker than the same mixture with the addition of coarse gravel. For example, a mixture of cement 1, sand 3 will show a lower strength than cement 1, sand 3 and gravel 4, though the latter mixture contains only half as much cement as the former. This is due to the reduction of the voids in the mass by the addition of coarse gravel."

In the manufacture of concrete blocks Mr. Newberry emphasises the advantages of the use of a certain proportion of coarse gravel or screenings instead of sand, and also shows that there is an advantage in adding slaked lime to the mixture, this cement 1, sand 3 will show a lower strength and lessening the penetration of water. A good proportion is: cement 1, hydrate lime ½, sand and gravel 6. A proper amount of water is essential, and the mixture should be as wet as it can be without sticking to the plates, and without sagging or becoming distorted when taken from the machine. Mixing machines are especially to be desired, in order to secure a uniform mixture, and batch mixers are to be preferred to continuous machines.

When Portland cement concrete blocks are well made, of good sand and gravel or limestone screenings, they should have a compression strength of more than 2,000 pounds per square inch at four weeks, and more than 3,000 pounds after one year.

"One of the chief faults often observed in work done with concrete blocks is their tendency to absorb water to such an extent as to cause dampness to appear on the interior surface. This is especially noticeable in blocks poor in cement and made too dry. The fault may be overcome by use of suitable materials and sufficient care in manufacture.

"The terms porosity, and permeability, are often used, and by many supposed to be of the same meaning. The porosity of concrete is, however, the proportion of

voids, or empty spaces, which it contains, while the permeability is the rate of speed with which water, under a certain pressure, will pass through it. All concretes and mortars are more or less porous, and all are somewhat permeable by water under heavy pressure. It is well known that, with the same proportion of cement, mixtures of fine sand are more porous than those of coarse sand. The latter are, however, much more permeable than the former. Feret has shown that the porosity is the total amount of voids contained in the mass, while the permeability depends on the size of the individual openings. The least porous concrete may, therefore, be the most permeable, and vice versa. If, however, both fine and coarse grains are present in proper proportion, the mass will show the least porosity and at the same time be the least permeable. The concrete which best resists water will therefore be that which is most dense, provided a sufficient amount of fine grains are present."

So far as the important question of cost is concerned, Mr. Newberry gives a computation of costs of blocks 9 inches high, 32 inches long, and 8 inches wide, amounting to 22.5 cents apiece, with cement at $1.50 per barrel, such blocks selling at about 30 cents apiece, or higher in localities where brick and stone are costly.

In general it appears that a finished wall, such as can readily be laid with concrete blocks, will cost about one-half that of a common brick wall, while the cost of stone is practically prohibitive in comparison.

"Those who can make blocks for their own use, as at large factories where much building is done, can make and lay them at a cost far below that above stated. Laborers can be put to work making blocks when not otherwise employed, and a stock thus constantly kept in readiness. At localities where sand and gravel are to be had for the cost of hauling, 8-inch blocks of 1 1-3 cubic feet can be made at a cost of 15 cents each and laid up for 5 cents more, making total cost of wall of 15 cents per cubic foot, or about half that of common brick. The convenience, durability, beauty and economy of this type of construction, for industrial purposes, is so great that no manufacturer who has made trial of it will ever want to use anything else in making additions to his works."

INDUSTRIAL AUTOMOBILES.

RECENT DESIGNS OF INDUSTRIAL AND MILITARY AUTOMOBILES AT THE COMPETITIVE TRIALS OF THE AUTOMOBILE CLUB OF FRANCE.

Ch. Dantin—Génie Civil.

DURING July and August of this year there was held under the auspices of the Automobile Club of France an interesting series of competitive trials of vehicles adapted for industrial and military purposes. The results were both interesting and important, showing the extensive development which has taken place in this class of automobiles, and hence the extended account of the vehicles exhibited, as given in *Le Génie Civil* by M. Ch. Dantin forms a desirable contribution to technical literature.

The industrial vehicles were divided into two classes, the first including those intended for the public transport of passengers, and those carrying up to 500 kilogrammes of merchandise; the second class covered vehicles carrying more than 500 kilogrammes of merchandise. The military vehicles were subjected to the same tests as the second class of industrial automobiles, but were considered as forming a separate class, the Ministry of War uniting with the Automobile Club in the conduct of the trials.

The tests included the completion of a circular road tour, starting from Paris, and passing through Amiens, Dieppe, Havre, and Rouen, back to Paris again, this circuit making a total of about 875 kilometres, or more than 540 miles for the lighter vehicles, and a somewhat shorter route for the heavy machines included in the second class. The daily allotment of distance varied from 50 to 150 kilometres, stop of one or two days being made at the larger cities to permit exhibitions of the competing vehicles to be held.

The trials were successfully held from

July 28 to August 8, and of the 56 vehicles which started all but four completed the circuit. Of the four which failed three met with unavoidable accidents from external causes, so that the trials demonstrated the general reliability of the various machines in a high degree.

In his papers M. Dantin describes the different machines, photographs also being given, but we can give but a general account of the leading types here, with some comments upon the broad results. The omnibuses resembled for the most part the typical horse-drawn omnibus of Paris, although in some cases the influence of the touring car upon the design was evident.

A number of light delivery wagons were included among the entries in the first class, but the vehicles of the most importance were the trucks, lurries and military wagons.

With the exception of the Serpollet machines, which were constructed with that engineer's well-known flash boiler and steam-engine, the vehicles were all equipped with gasoline motors, but it is a matter for comment that in numerous cases the engines and carburetters were also adapted to be used with alcohol.

Pneumatic tires were used in but few examples, solid rubber tires being the rule, while iron tires were also employed.

Full details of the performances of the various machines cannot be given until the full report of the technical commission of the Automobile Club is completed. At the same time M. Dantin is able to make some interesting comments upon the military wagons, perhaps one of the most important portions of the subject.

Three of the army wagons which entered the trials received awards and were purchased by the War Department: the Delahaye, the de Dion-Bouton, and the Gillet-Forest machines. It is a matter of especial interest that two of these vehicles, the Delahaye and the Gillet-Forest, were distinctly different in design from the accepted type of pleasure vehicle. As M. Dantin well remarks, it is a very encouraging thing to see a recognition of the fact that something more is necessary than to put an ordinary wagon body upon the chassis of a pleasure vehicle. The conditions of ordinary industrial service demand especial attention in connection with the proper design of delivery wagons and similar vehicles, and this is even more true in connection with the design of wagons for the necessarily severe requirements of military service.

For military service the question of tires is of great importance. In some of the army wagons entered in the trials the tires were excessively heavy, more so than the service warranted. But one of the military vehicles was provided with pneumatic tires, and it is the general opinion of military men that these are unsuited for army service. Iron tires were used on some of the machines, but their use did not appear to benefit the mechanism, while the wheels themselves showed traces of fatigue after the comparatively short run.

In the opinion of M. Dantin the military automobiles were given a higher speed than is necessary in actual service. Instead of 20 to 25 kilometres per hour, a speed of 15 kilometres is sufficient for army wagons, and reliability and efficiency are the essentials rather than speed.

On the whole it is most satisfactory to perceive that some attention is being paid to industrial automobiles, and that high-speed pleasure vehicles are not considered the only thing. It has long been a stock argument of the racing enthusiast that the development of the high-powered high-speed automobile would be of great benefit to the designers of industrial vehicles. This is true, however, to but a limited extent, and the elements which constitute a satisfactory business or military wagon must be largely worked out in accordance with the actual requirements, and not from race track experience. Much valuable information will doubtless be gained from such trials as those which have just been conducted by the Automobile Club, and these may now well be supplemented by the putting of the successful vehicles into actual service. Questions of wear and tear, of rough usage at the hands of ignorant and careless drivers and loaders, and all the innumerable tests of working service, will reveal points for improvement and reinforcement, and it is out of such experience that the wholly satisfactory industrial automobile will be perfected.

STEAM TURBINE CLASSIFICATION.

A REVIEW OF VARIOUS FORMS OF STEAM TURBINES WITH RESPECT TO THE MANNER OF ACTION OF THE STEAM.

Storm Bull—Western Society of Engineers.

IN considering the steam turbine as a prime mover it is not uncommon to regard it in somewhat the same category as the hydraulic turbine, and for some reasons such a classification is natural. This feature is well brought out in a paper recently presented before the Western Society of Engineers by Professor Storm Bull, and some abstract of his views may be here reviewed as aiding to give a clearer understanding of this group of machines.

"As there seems to exist a great deal of confusion in the minds of many engineers as to the essential differences between the various turbines, an attempt will here be made to give a classification, based on the manner in which the steam acts in the several wheels. Such a classification should not be based on external appearances, nor on speed, but only on the essential different ways in which the energy of the steam is utilized in the various turbines. The real difference between a steam engine and a steam turbine, is that, in the first named the pressure or tension of the steam is utilized directly, whereas in the latter the energy of the steam—as measured by the pressure and temperature—is first changed into kinetic energy, and it is only after this has occurred that the turbine wheel is ready to absorb it.

"The parallelism between the water and steam turbines is, therefore, complete, and the only essential difference between the two is that in the latter the acting fluid—steam—is compressible, whereas for all practical purposes in this connection, water may be assumed to be non-compressible. But, notwithstanding this difference, it seems but rational to use the same classification for both, although, as will be seen later, the fact that the steam turbine uses a compressible fluid, makes possible a very much larger variety of turbines than is possible in water turbines. As you probably all know, these latter are classified according to whether the water, when it comes to the turbine wheel, is under atmospheric pressure or under a high pressure; or to put it a little differently, whether the velocity of the water at the entrance to the turbine wheel is that due to the full head at that place, or whether the velocity is smaller than that. The turbines belonging to the first named class, have been named 'impulse turbines,' the latter, 'reaction turbines,' and the same definitions may be used for classifying steam turbines, changing the word head to pressure, and the atmospheric pressure to pressure of condenser. There would, consequently, be two classes of steam turbines, according to whether the energy of the steam, when reaching the turbine wheel, had been all changed into a kinetic form, or, if only partially so, the first class being named impulse wheels and the second one reaction wheels. These are, as everybody will see, very inappropriate, as there is no turbine wheel, whether utilizing the energy of falling water, or of expanding steam, that does not utilize the reaction of the flowing fluid, and that, consequently, all turbine wheels are reaction wheels. It would, therefore, seem to be quite rational to introduce new names for these two classes; at least for the steam turbine. The name of a class should be indicative of the essential characteristic of the class, and as a consequence, I propose as names for these classes—in harmony with one of the highest authorities of Germany, Mr. Wm. Gentsch—those of velocity turbines and pressure turbines, so that, for instance, the de Laval turbine would be a velocity turbine, and the Parsons, a pressure turbine."

The classification of steam turbines is complicated somewhat by the fact that it is possible with steam to introduce the so-called multi-stage turbine, and thus enable the velocity to be reduced. This enables the speed to be reduced in several stages and thus avoid some of the constructive difficulties inseparably connected with high rotative speeds.

The Rateau turbine, which has already been fully described in these pages, is classified by Professor Bull as a velocity

turbine, although it is sometimes placed among the pressure turbines. Here the space between each wheel forms a reservoir, from which the steam flows into the next guide wheel, the expansion taking place in the guide wheels, except so far as it is necessary to overcome the resistance in the turbine wheels.

In many stage pressure turbines, the pressure is gradually reduced from the moment the steam enters the first guide wheel until it enters the condenser. The expansion of the steam takes place both in the guide and turbine wheels, the velocity of the steam also increasing, and more rapidly, toward the end than to begin with. The most prominent example of the class of steam turbines is that of Parsons' which is now being built in large numbers, and up to 10,000 K. W., in nearly all of the large industrial centers of the world. Depending on the pressure of the steam and of the power of the turbine, the number of wheels in a Parsons turbine may be as large as 80, although about 60 probably is more nearly the average. It is of course quite possible to build a Parsons turbine with a very much smaller number of wheels, and evidently such a turbine would be very much cheaper to build. The drop of pressure would then be correspondingly greater for each wheel, also the velocity of the steam as well as that of rotation, and consequently the number of revolutions. If, therefore, it be desired to design a wheel with a comparable low number of revolutions, it is necessary to use a large number of wheels, and presumably this consideration has been the leading one at least in the choice of the number of wheels in the Parsons wheel as it is built. Questions of the strength of materials necessarily also enter the problem, and to a certain extent also the efficiency of the turbine. With a high velocity of the steam, the friction per running foot necessarily must be greater than for a low velocity, as it is supposed to vary with the square of the velocity; but at the same time the length of the path along which the steam must flow is being reduced by increasing the pressure drop, so that the question, when the friction is the smallest, is not an easy one to solve.

The question of vacuum in the operation of steam turbines is discussed by Professor Bull in a very clear and interesting manner.

"A steam turbine can, of course, be run non-condensing, and its efficiency, if designed for this purpose, is probably as good as that of the non-condensing engine. But it is a fact, which is established by a large number of tests, that it is very much more important to have a good vacuum for a steam turbine than for a reciprocating engine, because the gain in economy is very much greater. It is therefore not unusual to hear of 28-in. vacuum for a steam turbine, and such high vacuum has only become possible by the introduction of new and improved condensers and air pumps, which owe their origin to the demands of the designers of the steam turbines. Why the gain in economy, because of a high vacuum, should be so much higher for the steam turbine than for the ordinary steam engine, is a question which has troubled a great many persons. The answer is, however, quite simple. Because of the increased condensation, it has been found unprofitable to extend the expansion down to the back pressure line in the steam engine, so that the steam, when exhausted, possesses a considerable amount of energy over and above that at the pressure of the condenser, which energy consequently is lost. In the turbine this is entirely different, as the condensation is so small that it does not need to be taken into consideration, and the energy of the steam is changed into a kinetic form, and which, in amount, is proportional to the difference in pressure between that of admission and of condenser. This energy can be utilized, except for friction losses—down to a certain minimum, corresponding to the necessary velocity of the steam when it leaves the last wheel, and which is the same, whether the vacuum is high or low. Although, therefore, there is gain in economy for the steam engine by increasing the vacuum, yet it cannot be so great as for the steam turbine, because the losses of condensation increase so much more rapidly than in the case of the turbine. It need hardly be stated here that too much money may be paid in order to get a high vacuum; the extra expense may more than outweigh the gain in steam consumption."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 279
ELECTRICAL ENGINEERING 286
INDUSTRIAL ECONOMY 293
MARINE AND NAVAL ENGINEERING..... 294
MECHANICAL ENGINEERING 295
MINING AND METALLURGY..... 305
RAILWAY ENGINEERING 312
STREET AND ELECTRIC RAILWAYS..... 315

CIVIL ENGINEERING

BRIDGES.

Arch.

The Plauen Viaduct. Illustrated description of this viaduct in Saxony which comprises the largest arch masonry ring in the world. 2000 w. Sci. Am Sup—Sept. 16, 1905. No. 71904.

Bascule.

Bascule Bridge over the Oder River, at Stettin (Pont à Basculement sur l' Oder, à Stettin). A Bidault des Chaumes. Well illustrated description of rolling-lift bridge in northern Germany. 1 Plate. 1500 w. Génie Civ—Aug. 19, 1905. No. 72134 D.

Brooklyn Bridge.

The Extension of the Manhattan Terminal of the New York and Brooklyn Bridge. General remarks on the many great engineering works in progress, to improve the terminal facilities of the transportation lines of New York City,

We supply copies of these articles. See page 319.

and especially discussing the plans proposed for improving the terminal named. Ills. 2500 w. Archts & Builds Mag—Sept. 1905. No. 71684 C.

Budapest.

The Elizabeth Bridge at Budapest. Illustrated description of a handsome bridge almost identical with the "eyebar" design proposed for the new East River bridge at New York. Editorial. 2500 w. Sci Am—Sept. 9, 1905. No. 71837.

Floors.

Waterproofing Bridge Floors. A review of the tests reported in a paper by W. C. Cushing, read before the Am. Ry. Engng. & Main. of Way Assn. 3000 w. Engng—Sept. 1, 1905. No. 71784 A.

Foot-Bridge.

The Ginn Field Foot-Bridge, Boston Metropolitan Park System. William T. Pierce. Illustrated description of a small wooden foot-bridge of pleasing design. 3000 w. Eng News—Sept. 14, 1905. No. 72047.

New York City.

Report of Commissioner of Bridges of New York City. Data, principally in regard to the East River bridges, taken from the very interesting report of Bridge Commissioner George E. Best. 2700 w. R R Gaz—Vol. XXXIX. No. 10. No. 71859.

Plate Girder.

A Long Single-Track Plate-Girder Span. Illustrated and describes a single-track deck span on the Mahoning Division of the Erie R. R., with two plate girders 131 ft. 4 in. long, 9 ft. apart on centers, which carry a track with a curvature of 3 degrees 30 minutes, its construction and erection. 2000 w. Eng Rec —Sept. 16, 1905. No. 71971.

Quebec.

Progress on the Quebec Bridge. Gives recent photographs and data of the progress made in the construction of this bridge across the St. Lawrence River. 3500 w. Eng Rec—Sept. 16, 1905. No. 71968.

The 1800 Ft. Span Cantilever Bridge Across the St. Lawrence River at Quebec. An illustrated article giving interesting information regarding the cantilever portion of the structure. 1000 w. Eng News—Sept. 14, 1905. No. 72050.

The St. Lawrence River Bridge at Quebec, Canada. Illustrated description of a bridge designed to carry two lines of railroad, two trolley lines, two highways and two sidewalks. 900 w. R R Gaz —Vol. XXXIX. No. 11. No. 71913.

Reinforced Concrete.

A Reinforced Concrete Double-Track Railroad Arch Bridge. Drawings and description of a bridge being constructed near Vulcanite, N. J., to carry two main line tracks of the Central R. R. of N. J. over a highway. 1500 w. Eng Rec—Sept. 9, 1905. No. 71897.

Reinforced Concrete Ribbed Arch Bridge at Deer Park Gorge. J. B. Strauss. Illustrated description of an interesting foot-bridge and the methods of erection. The advantages of the ribbed bridge are said to be its economy, adjustability of the structure under settlement, and accessibility for inspection. 1600 w. Eng News—Sept. 21, 1905. No. 72053.

Thebes.

The Erection of the Thebes Bridge Superstructure. Illustrated detailed description of the methods used in erecting the double-track railroad bridge over the Mississippi River at Thebes, Ill. 2000 w. Eng Rec—Sept. 16, 1905. No. 71974.

Transporter.

The Widnes-Runcorn Transporter Bridge. Illustrated detailed description of this bridge on the river Mersey, and its electrical working. 2700 w. Tram & Ry Wld—Sept. 14, 1905. No. 72088 B.

An Electric Aerial Ferry. Frank C. Perkins. Illustrated description of a type of bridge in operation across the Duluth Ship Canal. Electric motors furnish the power for the ferry car. 1200 w. Elec N Y—Aug. 30, 1905. No. 71976.

Viaduct.

Concrete Viaduct at Riverside, California. H. Hangood. An illustrated detailed description of an important structure over the Santa Ana River. It has a total length of 984 feet, and an average height of 55 feet. 3500 w. Eng Rec—Sept. 9, 1905. No. 71894.

CONSTRUCTION.

Building Collapse.

The Collapse of a Department Store Building at Albany, N. Y. Gives a summary of the circumstances of the accident, which occurred during reconstruction work. Also editorial. Ills. 5000 w. Eng News—Sept. 7, 1905. No. 72044.

The Collapse of the Meyers' Building, Albany. Explains the conditions existing, and the cause of the disaster, giving extracts from the report made by the committee of examination. 1300 w. Eng Rec—Sept. 2, 1905. No. 71890.

Caissons.

A Peculiar Pneumatic Caisson Wreck. Describes an accident on the foundation work of the new United States Express Co. building on Greenwich st., New York. Ills. 1000 w. Eng Rec—Sept. 16, 1905. No. 71970.

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Chicago Tunneling.

Settlement of Chicago Buildings Due to Tunneling. From the supplement to the report of the commission giving a detailed statement of places where the settlement of streets and buildings can be attributed to this work. 1800 w. Eng Rec —Sept. 23, 1905. No. 72224.

Cistern.

A 75,000 Gallon Concrete Steel Cistern. Edward Godfrey. Illustrated description of a cistern, to be used for fire protection, built at Allegheny, Pa. 1200 w. Eng News—Sept. 28, 1905. No. 72283.

Coffer-Dams.

Steel Coffer-Dams in the Chicago River. E. James Fucik. Describes the conditions found in the Chicago River and the use of a steel sheeting for coffer-dams, describing in detail the two types used. Ills. 1800 w. Technograph No. 19, 1904-1905. No. 72266 D.

Concrete Plant.

Concrete Plant for the Brooklyn Anchorage of the Manhattan Bridge. An illustrated account of the concrete machinery and special plant which has been installed at a great cost with the aim of executing the work with the greatest economy and rapidity. 2500 w. Eng Rec —Sept. 9, 1905. No. 71896.

Dams.

Dams for the New Plant of the United Shoe Machinery Co., Beverly, Mass. Describes the construction of two concrete and one earth dam. 3000 w. Eng Rec—Sept. 2, 1905. No. 71893.

Earth Dams with Concrete Core Walls. Clemens Herschel. Gives the writer's views and methods on this subject as expressed in a discussion, with a history of, and justification of this form of constructure. 2800 w. Eng News—Sept. 7. 1905. No. 72043.

Movable Dam and Lock of the Rice Irrigation and Improvement Association, Mermentau River, La. Illustrates and describes work carried out to effectually shut out the salt water, which injured the rice crops, and for preventing overflow of the adjacent low lands. 600 w. Eng News—Sept. 28, 1905. No. 72280.

The Scioto River Storage Dam at Columbus, Ohio. John H. Gregory. An explanation of conditions at Columbus, and the need of additional supply, describing the dam and reservoir which are now under construction. Ills. 4000 w. Eng Rec—Sept. 9, 1905. No. 71899.

The Determination of Pressures on Masonry Dams (Zur Ermittlung von Kantenpressungen bei Sperrmauern). F. Stupecky. Diagrams and discussion of formulæ and methods. 1500 w. Oest Wochenschr f d Oeff Baudienst—Aug. 19, 1905. No. 72111 D.

Engine Foundations.

Cement Mortar Blocks and Engine Foundations. Paul J. Johnson. Gives some practical results with suggestions. 2000 w. Min Rept—Sept. 21, 1905. No. 72237.

Excavator.

A Submarine Rock Excavator. From a paper by G. C. Hepburn, published by the Inst. of Civ. Engrs. Illustrated description of a drilling apparatus used in Australian harbor improvements. 1000 w. Eng Rec—Sept. 16, 1905. No. 71972.

Fireproof Buildings.

Fireproof Construction the Only Method of Reducing the Nations Enormous Fire Loss. Alcide Chausee. Read before the Am. Soc. of Munic. Imps. Gives statistics of losses by fire, urging the importance of strict building regulations. 1800 w. Eng News—Sept. 21, 1905. No. 72055.

Foundations.

Chicago Foundations. E. C. Shankland. Briefly considers the evolution from the old spread or floating foundation to the present use of concrete caissons. 3300 w. Technograph—No. 19, 1904-1905. No. 72261 D.

Foundations on Muddy Ground (La Fondation des Ouvrages en Terrains Vaseux). Lt. Col. G. Espitallier. Abstract of article by Col. Petitbon in the *Revue de Génie*, on difficult foundation work at Saigon, French Indo-China. 2200 w. Génie Civ—Sept. 15, 1905. No. 72142 D.

Framework.

The Theory of Framework with Rectangular Panels, and Its Application to Buildings which Have to Resist Wind. Ernst F. Jonson. Develops the exact theory of frameworks with rectangular panels, and suggests methods that may be of use in actual designing. Mathematical. 1800 w. Pro Am Soc of Civ Engrs—Sept. 1905. No. 72291 E.

I-Beams.

I-Beam Buckstays. J. H. Granbery. Shows the advantage in cost and strength gained by the use of buckstays of I-beam and channel sections in place of the tee-rail. 600 w. Eng & Min Jour—Sept. 16, 1905. No. 71931.

Lighthouse.

Construction of the Beachy Head Lighthouse, England (Construction du Phare de Beachy Head, Angleterre). Illustrated description of lighthouse built 700 feet off shore, and of cableway used in its construction. 1 Plate. 1500 w. Génie Civ —Aug. 26, 1905. No. 72136 D.

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Reinforced Concrete.

A Unit Frame Reinforcement System of Concrete Steel Construction. Illustrates and describes a unit frame reinforcement for concrete girder and floor construction. 1200 w. Eng News—Aug. 31, 1905. No. 72027.

New Design for Armored Concrete Tunnels. Illustrates and describes a design in which there is no protective lining, and thin steel plates and channels are adopted to afford a built-up ring. 1400 w. Engr Lond—Sept. 15, 1905. No. 72062 A.

The New Reinforced-Concrete Shops and Car Houses of the Central Pennsylvania Traction Company, at Harrisburg, Pa. Mason D. Pratt. Well illustrated description. Reinforced concrete is used throughout. 2000 w. St. Ry Jour—Sept. 2, 1905. No. 71729 C.

The Pugh Power Building, in Cincinnati, O., constructed of Reinforced Concrete (The Pugh Power Building, ein Hohes Gebäude aus Eisenbeton in Cincinnati, O.). Illustrated description. 1 Plate. 700 w. Beton u Eisen—No. 9, Sept., 1905. No. 72127 F+H.

A Reinforced-Concrete Coal Pocket, Atlantic City Water Works. Kenneth Allen. Illustrates and describes a recently completed coal pocket of unique form, and the method of construction. 1200 w. Eng Rec—Sept. 16, 1905. No. 72056.

Reservoirs.

Method and Cost of Concreting Jerome Park Reservoir, New York City. Halbert P. Gillette. Illustrates and describes the work of lining 250 acres of reservoir basins with concrete, discussing the economics and suggesting improvements. 1800 w. Eng News—Sept. 21, 1905. No. 72056.

Ancient Reservoirs of Carthage. Brief illustrated description of these remarkable structures. 700 w. Sci Am—Sept. 23, 1905. No. 72206.

Roof Shield.

The New Roof Shield for the Metropolitan Railway Tunnel of Paris. R. Bonnin. Explains the lack of success of the half section shield, which was to have been used for this work, and illustrates and describes the new type and its operation. 4800. Eng News—Sept. 28, 1905. No. 72281.

Simplon Tunnel.

Simplon Tunnel (Simplon-Tunnel), Abstract of report on the progress of work to the end of June, 1905. Tables. 1000 w. Schweiz Bauzeitung—Aug. 25, 1905. No. 72118 D.

Standpipe.

A Large Reinforced Concrete Standpipe. George W. Blodgett. Describes a standpipe 110 ft. high and 50 ft. in diameter built in the town of Attleboro, Mass. 1000 w. R. R. Gaz—Vol XXXIX. No. 11. No. 71919.

Steelwork.

Steelwork of the Wanamaker Building, Philadelphia. Begins an illustrated description of the steelwork in one of the largest department stores ever erected. 2000 w. Eng. Rec. Sept. 2, 1905. Serial. 1st part. No. 71892.

Steel Structural Work for Railway Stations and Workshops (Die Lütticher Weltausstellung. Eisen Konstruktionen für Bahnhöfe und Werkstätten). Bruno Schwarze. Illustrated descriptions of roofs, cranes, etc., of railway shops and stations. 1200 w. Glasers Annalen—Sept. 15, 1905. No. 72126 D.

Tunnels.

The Pennsylvania R. R. Tunnel Under Capitol Hill, Washington, D. C. An illustrated article giving details of the methods of excavation and the machinery employed in this example of soft ground tunneling. 2800 w. Eng News—Sept. 14, 1905. No. 72049.

Progress on the Battery Tunnel, New York. An illustrated report of the progress made and methods adopted in the construction of this interesting work. 1200 w. Eng Rec—Sept. 9, 1905. No. 71898.

MATERIALS OF CONSTRUCTION.

Brick.

Tests of Sand-Lime Brick. L. E. Curfman. Gives a report of tests made by the writer and the results. 3500 w. Technograph—No. 19, 1904-1905. No. 72265 D.

The Manufacture of Sand-Lime Brick. Illustrated description of a manufacturing plant and its operation. 1300 w. Eng News—Aug. 31, 1905. No. 72023.

The Evolution of the Babylonian Brick. Prof. Edgar James Banks. An account of the history as shown by the interesting discoveries made at Bismya, in Central Babylonia. Ills. 1200 w. Eng News—Sept. 7 1905. No. 72046.

Cement.

Cement and Concrete Tests at the St. Louis Exposition. Richard L. Humphrey. Gives a description of the results of the tests which were made. 4000 w. Eng News—Sept. 21, 1905. No. 72057.

Changes Which Take Place in the Clinkering of the Lehigh Valley "Cement Rock." Richard K. Meade. Read before the Assn. of Portland Cement Mfrs. A report of experimental investigations. discussing results. 2000 w. Cement—Sept. 1905. No. 72284 C.

We supply copies of these articles. See page 319.

The Chemical Analysis of Limes and Cements. M. J. Malette. Remarks on the advantages and need of agreement in the methods of testing such materials, giving a method considered as giving a very satisfactory guarantee of exactitude. 2000 w. Builder—Sept. 2, 1905. No. 71666 A.

Concrete.

A System of Safeguards Against Freezing in Concrete Building Construction. Illustrates and describes the means adopted to prevent damage by frost in constructing the shops of the Foster-Armstrong Piano Co., at Rochester, N. Y., which proved entirely successful. Also editorial. 2500 w. Eng. News. Sept. 7, 1905. No. 72040.

Notes on Concrete. C. E. P. Sankey. On specifications for concrete, discussing the percentage of voids, quality and quantity of mortar and other ingredients, and methods of determining them, the making of concrete, etc. 2000 w. Engng—Sept. 1, 1905. No. 71778 A.

Concrete Blocks.

The Manufacture and Use of Concrete Blocks. F. W. Hagloch. Considers the selection of material, proportioning and curing of concrete blocks. 3000 w. Eng News—Aug. 31, 1905. No. 72028.

Hollow Concrete Block Building Construction. S. B. Newberry. Discusses these blocks as a building material, their manufacture, properties, cost, etc., giving two designs illustrating their use. 2200 w. Cement—Sept., 1905. No. 72285 C.

Non-Metallic Materials.

Specific Gravity and Weight of Building Stone, Cements, and Other Non-Metallic Structural Materials. Edwin C. Eckel. Aims to give reliable data on the specific gravity and weight per cubic foot of various classes of building stones, and also of plasters, limes, and cements. 2000 w. Eng News—Sept. 7, 1905. No. 72039.

Reinforced Concrete.

Consistency in the Reinforcement of Concrete. Louis F. Brayton. Discusses the use of this material and the important things to be considered in the designs submitted. 6000 w. Technograph—No. 19, 1904-1905. No. 72262 D.

Comment on the Advantages and Limitations of Reinforced Concrete. Charles S. Hill. Read before the Assn. of Portland Cement Mfrs. Deals with the principle of reinforced concrete; its claims as a structural material; the qualities of design and workmanship; and the evils attending it. 2000 w. Min Rept—Sept. 14, 1905. No. 71923.

Graphical Calculation of the Moment of Resistance of Reinforced-Concrete Plates and Plate Girders (Graphische Berechnung des Widerstandsmomentes von Eisenbeton-Platten und Plattenbalken). P. Weiske. Mathematical discussion. 1000 w. Beton u Eisen—No. 9, Sept., 1905. No. 72128 F+H.

International Association for Testing Materials (Association Internationale pour l'Etude et l'Essai des Matériaux). Note by M. Maynard on changes of volume of cement when subjected to moisture and immersed in water, and on reinforced-concrete tests and phenomena. Diagrams and curves. 3000 w. Rev. Tech—June 10, 1905. No. 72146 D.

See also Civil Engineering, Construction.

Roofing.

Terne Plates for Tin Roofing. William Martin. Read before the Nat. Assn. of Master Steel Metal Workers. Discusses the causes of the decadence of terne plates as a roof covering. Also discussion. 3500 w. Am. Arch—Sept. 2, 1905. No. 71683.

MEASUREMENT.

River Profile.

River Profile Work of the United States Geological Survey, Kennebec River, Maine. Arthur D. Butterfield. Describes work carried out in Maine, and confined to the part of the Kennebec River extending from the top of the dam at Showhegan to the highway bridge at The Forks. Describes methods and work giving general results. 3500 w. Eng News—Aug. 31, 1905. No. 72024.

Simplon Tunnel.

The Final Results of the Measurements of the Simplon Tunnel (Die Schlussergebnisse der Absteckung des Simplontunnels). Prof. M. Rosenmund. Discussion of the small errors in direction and level found after the tunnel had been finished. 2400 w. Schweiz Bauzeitung—Sept. 9, 1905. No. 72120 D.

MUNICIPAL.

Cesspool.

The Knobloch Cesspool (Die Knobloch'sche Senkgrube). Prof. O. Richter. Illustrated description of a biological chemical process for purifying cesspool contents. 1 Plate. 1500 w. Oest Wochenschr f d Oeff Baudienst—Aug. 26, 1905. No. 72113 D.

Columbus, O.

Progress on the Sewage Works and Water Softening and Purification Works of Columbus, Ohio. Julian Griggs. Abstract of a paper presented before a gathering of municipal organizations, giving information of the progress made on these

improvements. 1400 w. Eng News—Sept. 21, 1905. No. 72058.

Feldsberg.

Water Supply and Sewage of the Town of Feldsberg, Lower Austria (Trinkwasserleitung und Kanalisation der Stadtgemeinde Feldsberg, N. Oe.). Franz Florian. Description of waterworks, mains, sewers, etc., of a small town, with illustrations and plans. 4 Plates. 4500 w. Oest Wochenschr f d Oeff Baudienst —Sept. 9, 1905. No. 72114 D.

Incinerating Plant.

Electric Light and Rubbish in New York City. S. S. Edmonds. Describes the new combined rubbish incinerator and electric lighting plant at Delancey Slip, Manhattan. Ills. 3000 w. Engr, U S A—Sept. 1, 1905. No. 71848 C.

London.

The Traffic of London. George S. C. Swinton. Reviews the report of the Royal Commission, appointed to inquire into the means of locomotion and transport in London. 7500 w. Nineteenth Cent —Sept., 1905. No. 71953 D.

Oiled Roads.

The Use of Oil on Macadam Roads and Oil-Asphalt Streets in California. Theodore F. White. Reviews the methods and results obtained by the use of oil, and the construction of asphalted-macadam roads. 1500 w. Eng News—Sept. 21, 1905. No. 72059.

Pavements.

Factors in Asphalt Paving Construction, Maintenance and Cost. Andrew Rosewater. Interesting statements in regard to the increase of this pavement, the cost, wearing capacity, construction, materials, maintenance, etc. 5000 w. Munic Engng—Sept., 1905. No. 71944 C.

Road Curves.

Radius and Width of Curves in Roads (Krümmungshalbmesser und Breite der Strassenwendeplätze). Prof. F. Loewe. Discussion of the layout of curves in streets and roads, with formulæ and diagrams. 3000 w. Zeitschr d Oest Ing u. Arch Ver—Aug. 25, 1905. No. 72166 D.

Sewage.

Sewage and Its Disposal. H. Lemmoin-Cannon, in *Technics*. Considers some of the principal methods used for its treatment and disposal. 3000 w. Sci Am Sup —Sept. 23, 1905. No. 72208.

Sewers.

Rainfall and Run off in Sewer Design. Charles Emerson Gregory. Extracts from a lecture before the Engng. School of Union College, Schnectady, N. Y., and a discussion before the Am. Soc. of Civ. Engrs., giving the latest advances in this subject. 4500 w. Munic Engng—Sept., 1905. No. 71942 C.

Smoke.

Municipal Control of Smoke. R. P. King. Condensed paper read before the League of Am. Municipalities. A review of municipal smoke prevention, with many suggestions of value. 2800 w. Eng News —Aug. 31, 1905. No. 72026.

Street Repairs.

The Organization and conduct of the Brooklyn Bureau of Street Repairs. Edwin J. Fort. Read before the Am. Soc. of Munic. Imp. Explains the organization under which the work in Brooklyn has been successfully carried on. 4000 w. Eng News—Sept. 28, 1905. No. 72279.

Tar Macadam.

Notes on Trials of Coal Tar Pavements at Saint Nazaire-sur-Loire, in 1904-1905. (Note sur les Essais de Goudronnage Executés à Saint-Nazaire-sur-Loire en 1904-1905). D. Guillou. Account of experience with tar macadam pavement. 1500 w. Rev Tech—June 10, 1905. No. 72145 D.

WATER SUPPLY.

Conduits.

The Most Economic Type of Hydraulic Power Conduits. Fred C. Frinkle. Address before the Twelfth Irrigation Congress. Describes the concrete and cement pipe now used in California, and the method of construction. 1500 w. Eng Rec—Sept. 2, 1905. No. 71888.

Coolgardie.

Water Supply for Coolgardie, Australia (Alimentation de Coolgardie en Eau Potable par une Conduite de 565 Kilomètres). Paul Raulin. Description, with plans and illustrations of steel pipe line 350 miles long, and 30 inches in diameter. 2000 w. Génie Civ—Aug. 26, 1905. No. 72137 D.

Edinburgh.

The Talla Water-Works. Illustrates and describes this recent addition to the Edinburgh water supply, giving information in regard to the work and its cost. 1400 w. Engr Lond—Sept. 1, 1905. No. 72009 A.

Fire Protection.

High Pressure Systems for City Fire Protection. Albert Blauvelt. A discussion of fire protection in the large cities of America. 5000 w. Cassier's Mag—Sept., 1905. No. 72257 B.

Fire Department Water Supply. Charles A. Hague. Read before the League of Am. Municipalities, at Toledo, O. A comprehensive review of requirements and methods. 7500 w. Munic Jour & Engr—Sept., 1905. No. 71689 C.

We supply copies of these articles. See page 319.

City Water-works Systems. E. G. Hopson. Discusses the water pressures of the domestic supply systems from the fire protection point of view. 6000 w. Ins Engng—Sept., 1905. No. 72250 C.

Flumes.

Reconstructing the Flumes on the Turlock Irrigating Canal. H. A. Crafts. Describes the permanent construction to take the place of the wooden flumes, which are already in serious decay. Ills. 1000 w. Eng Rec—Sept. 2, 1905. No. 71889.

Irrigation.

Address by Colonel Sir C. Scott Moncrieff before the British Association. Address before the engineering section, on the science of irrigation, describing what has been accomplished in various parts of the earth. 8500 w. Nature—Sept. 7, 1905. No. 71955 A.

On the Cost of Irrigation by Electrically Driven Pumps from Transmission Services. W. W. Wheeler. Read before the Pacific Coast Engng. Cong. Gives the writer's experience in Northern California. 2500 w. Jour of Elec—Sept. 1905. No. 72098 C.

The Truckee-Carson Irrigation Project. Herbert I. Bennett. An illustrated article explaining the purpose of this canal, and describing the work. 2000 w. Sci Am—Sept. 16, 1905. No. 71900.

The Truckee-Carson Reclamation Project. Enos Brown. Illustrated description of this great irrigation project undertaken by the government. 1700 w. Sci Am Sup—Sept. 16, 1905. No. 71903.

Time Test of a Great Irrigating System. H. A. Crafts. Brief illustrated description of the Turlock and Modesta irrigating systems, in California. 900 w. Sci Am—Sept. 2, 1905. No. 71831.

Pumping Station.

The New Lardner's Point Pumping Station, Philadelphia. Illustrated detailed description of the buildings, boilers, flues and chimneys, coal supply, piping system, pumping engines, conduits, etc. 4000 w. Eng Rec—Sept. 16, 1905. No. 71969.

Sterilization.

Sterilization of Water. Emile Guarini. Illustrated description of the De Frise ozonizing plant and its working. 1700 w. Sci Am—Sept. 2, 1905. No. 71834.

Water Pipes.

Cost of Laying Water Pipe, Atlantic City, N. J. Kenneth Allen. Gives cost figures for about three miles of 12 to 4-in. pipe. 500 w. Eng News—Sept. 14, 1905. No. 72051.

WATERWAYS AND HARBORS.

Antwerp.

The Port of Antwerp. Reviews briefly the development of this port to keep pace with the increase of commerce, and the scheme for the construction of new docks. Plans. 2000 w. Builder—Sept. 2, 1905. No. 71665 A.

Enlargement of the Port of Antwerp. Information concerning the plan adopted for the vast extension which will triple the area of the port, giving it 60 kilometers (37.3 miles) of running quays. 1600 w. U S Cons Repts—June, 1905. No. 72019 D.

Bank Protection.

The Use of Cobblestones Imbedded in Portland Cement in River Improvements (Die Anwendung von mit Portlandzement Gebundenen Klaubsteinen bei Flussregulierungen). Max Jesovits. Illustrated methods of protecting river banks. 400 w. Oest Wochenschr f d Oeff Baudienst—Sept. 9, 1905. No. 72115 D.

Canal Lifts.

Means for Overcoming Great Differences in Level by Vessels in Internal Waterways (Moyens de Faire Franchir les Grands Chutes par les Bateaux de Navigation Intérieure). A. de Bovet. Review of results of the recent Austrian competition for canal lifts, locks, inclined planes, etc. 6500 w. Mem Soc Ing Civils de France—Aug., 1905. No. 72184 G.

Preliminary Work on the Panama Canal. John F. Wallace. The second of a series of articles, which shows the physical and governmental red-tape difficulties encountered, and the necessary preparation and organization before work on the canal begins. 5000 w. Eng Mag—October, 1905. No. 71701 B.

See also Industrial Engineering.

Dredges.

Dredges (Les Dragues). A Baril. A general review, with illustrations of various types of river and seagoing dredges and their parts, partly taken from *Engineering*. 4000 w. Rev. de Mécanique—Aug. 31, 1905. No. 72185 E+F.

New Sea-Going Dredges. Day Allen Willey. Illustrates and describes the dredges used in improving the ship channel leading into New York harbor. 1200 w. Sci Am Sup—Sept. 2, 1905. No. 71835.

Evolution of the California Clam-Shell Dredger. H. A. Crafts. Illustrations, with remarks on the recent improvements in this type of dredger, which is especially adapted to river and reclamation work. 700 w. Sci Am—Sept. 30, 1905. No. 72288.

We supply copies of these articles. See page 319.

Hydraulic Suction Dredge on the Mississippi. Day Allen Willey. Illustrations showing the arrangement of the pumping and other machinery on the dredge "Beta," with description and account of service. 1000 w. Sci Am—Sept. 23, 1905. No. 72205.

Genoa.

The Development of the Harbor Works of Genoa (Die Bauliche Entwicklung des Hafens von Genua). E. Bavier. General historical account. Serial. Part 1. 2000 w. Schweiz Bauzeitung—Aug. 19, 1905. No. 72116 D.

Niagara.

To Dam Niagara. Discusses briefly the scheme under consideration of the International Waterways Commission for raising the level of Lake Erie by putting a dam across its outlet in the Niagara River. 1300 w. Engr Lond—Aug. 25, 1905. No. 71798 A.

Nile.

Some Problems of the Upper Nile. Sir William E. Garstin. An account of the schemes proposed for controlling the river, giving a brief description of the stream and its characteristics, and discussing the irrigation requirements of Egypt and the Soudan. 11500 w. Nineteenth Cent—Sept., 1905. No. 71952 D.

Philadelphia.

The Improvement of the Delaware River and Harbor and the Landing Facilities of the Port of Philadelphia. George S. Webster. A description of the work done by the city of Philadelphia in conjunction with the United States Government in the improvement of the channels of the Delaware and Schuylkill Rivers, and the landing facilities of the port by the widening of Delaware avenue, and the construction of more commodious piers. Maps and illustrations. 3800 w. Jour Fr Inst—Sept., 1905. No. 71981 D.

Seawall.

Galveston's Great Seawall. Brief illustrated description of this great engineering work. 1200 w. Marine Rev—Aug. 31, 1905. No. 71800.

United States.

Notes on the Improvement of River and Harbor Outlets in the United States. L. J. Le Conte and William W. Harts. Discussion of the paper by D. A. Watt, presented in *Proceedings* for May. 5200 w. Pro Am Soc of Civ Engrs—Sept., 1905. No. 72293 E.

MISCELLANY.

Executive Engineers.

The Executive Engineer. A lecture by Prof. White on the necessity of executive training for engineers who aspire to places of high honor. 3000 w. Technograph—Nov. 19, 1904-1905. No. 72264 D.

Florida Everglades.

The Florida Everglades: Their Legal Status, Their Drainage, Their Future Value. S. L. Lupfer. Describes these marshes, and discusses what has been done toward reclaiming them, and the legal causes of trouble. Map. 5000 w. Eng News—Sept. 14, 1905. No. 72052.

Legal Engineers.

The Legal Position of an Engineer. Gives a general view of an engineer's position and considers the form of agreement under which he may be employed. 3000 w. Engr Lond—Aug. 25, 1905. No. 71796 A.

Sanitation.

Sanitary Engineering in the South and the Labor Question. J. N. Hazlehurst. Read before the Am. Soc. of Munic. Imp. Describes the progress of sanitary work in the South, and some of the difficulties met in the construction of these works, giving information concerning the negro labor. 2000 w. Eng News—Sept. 21, 1905. No. 72054.

ELECTRICAL ENGINEERING

COMMUNICATION.

Faults.

Notes on the Localization of Cable Faults. Henry Joseph. The writer aims to investigate the conditions under which tests already published are likely to be useful, and to ascertain what steps should be taken to find the position of a fault, the nature of which is such that no test known to the writer can be applied with any degree of certainty. The conditions appertaining to a three-wire continuous current system with the neutral earthed at the station are particularly considered. 2500 w. Elec Rev Lond—Sept. 15, 1905. No. 72083 A.

Fire Alarm.

Suggested Improvements in Fire Alarm Telegraph Systems. William Brophy. Read before the Int. Assn. of Munic. Electn's. Suggests improvement in the circuits, showing the weakness of the present method of distribution. 5000 w. Fire & Water—Sept. 16, 1905. No. 71911.

Magini Telegraph.

An Important Innovation in Telegraphy. Editorial remarks on the recent invention of Signor Magini, and its importance in connection with telegraphy. Briefly describes this new system, which appears to employ high-frequency currents on an ordinary wire, the receiving apparatus containing a self-restoring coherer. 1000 w. Sci Am—Sept. 23, 1905. No. 72201.

Postal-Commercial Co.

The Development of the Postal Telegraph-Cable Company. Charles P. Bruch. General account of the Postal Telegraph and Commercial Cable companies, with map. 2000 w. Elec Rev N Y—Sept. 9, 1905. No. 71727.

Space Telegraphy.

"Wireless" Telegraphy. Sir Wm. H. Preece. Paper before the British Assoc., giving a general review. 5000 w. Elect'n Lond—Sept. 1, 1905. No. 71748 A.

Directed Wireless Telegraphy. Brief account of experiments made by Dr. Ferdinand Braun, at Strasburg. Also editorial. 1800 w. Elec Rev, N Y—Sept. 16, 1905. No. 72091.

Spark Gaps. James Foster King. Gives briefly a history of conditions existing in the spark gap in a space telegraph transmitter. 1300 w. Elec Wld & Engr—Sept. 23, 1905. No. 72217.

Submarine Cables.

Submarine Cables (Unterseekabel) Hermann Hildebrandt. Historical, descriptive and statistical with illustrations and tables. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72101 D.

Telegraph Current.

Weak current Plants Connected to Heavy-Current Systems (Ueber Schwachstrom-Lieferungsanlagen in Auschlusse an Starkstromnetze). Hans Carl Steidle. A discussion of the use of current from lighting and power systems, for telegraphy and telephony, particularly in connection with storage-batteries. Diagrams. 4000 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72149 B.

Telephone Exchange.

Multiple Switchboard System for the Telephone Exchange at Würzburg, Germany (Vielfach — Umschalteeinrichtung für die Fernsprechanlage zu Würzburg). J. Jacob. Illustrated description of a central-energy exchange and connections. 3500 w. Elektrotech Zeitschr—Aug. 31, 1905. No. 72154 B.

Telephone Lines.

Telephone Lines with High Inductance (Ueber Telephonleitungen Hoher Induktanz). Ludwig Kusminsky. Mathematical discussion. 1500 w. Oest Wochenschr f d Oeff Baudienst—Aug. 19, 1905. No. 72112 D.

Telephony.

Telephony. Herbert Laws Webb. An illustrated review of the history and development of the telephone. 7000 w. Jour Soc of Arts—Sept. 15, 1905. Serial. 1st part. No. 72065 A.

DISTRIBUTION.

Junction Boxes.

The value of Junction Boxes, with Cut-Out Switches, in Underground-Cable Networks (Ueber den Wert Ausschaltbarer Abzweigmuffen in Unterirdischen Kabelnetzen). C. Ankersen. Description and discussion of protected and accessible switches which can cut out sections of cable. 1200 w. Elektrotech Zeitschr—Sept. 14, 1905. No. 72160 B.

Mains.

Notes on Main's Work and Fault-Finding. G. C. Knight. Gives suggestions for the laying of mains, testing and fault-finding and earth finding and the calculations involved. 5000 w. Elec Rev Lond—Aug. 25 and Sept. 1, 1905. Serial. 2 parts. No. 71762 each A.

Mercury-Arc Rectifiers.

Mercury Arc Rectifiers. P. D. Wagoner. Abstract of paper before the Ohio Electric Light Assoc., giving an illustrated description of the commercial outfit of the General Electric Co., for charging vehicle storage batteries. 2000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71721.

Rotary Converters.

Rotary Converters in Parallel with Storage Batteries (Umlaufende Einanker-Umformer in Parallelschaltung mit Pufferbatterien). B. Jacobi. Discussion of the use of rotary converters in connection with "floating" storage batteries on an electric distribution system, and particularly the arrangement on the electric railway at Remscheid, Germany. Diagrams. 1000 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72150 B.

See also Electrical Engineering, Generating Stations.

Starting Switch.

A new Automatic Starting Switch (Ein Neuer Selbstanlasser). Johannes Jessen. Illustrated description of automatic starting switch and resistances for electric motors. 2500 w. Elektrotech Zeitschr —Aug. 31, 1905. No. 72153 B.

Time-Limit Relays.

Time-Limit Relays. W. T. Fernandez. Discussion, with illustration and curve, of clock and bellows types of relays for automatically breaking electric circuits. 1500 w. Am Electr'n—Sept., 1905. No. 71741.

We supply copies of these articles. See page 319.

Wiring.

Wiring for Lamps and Motors—Meeting an Emergency. W. H. Wakeman. Describes the writer's plan of wiring and the changes made to meet an emergency. 900 w. Elec, N Y—Sept. 6, 1905. Serial. 1st part. No. 71978.

ELECTRO-CHEMISTRY.

Accumulators.

A Chat about Accumulators. S. R. Bottone. A consideration of the laws that govern the construction and action of a good accumulator. 1300 w. Elec Mag—Aug. 29, 1905. Serial. 1st part. No. 71979 A.

Acid Pickle.

Action of Acids on Iron and the Use of the Acid Pickle. Charles F. Burgess. Explains the term "pickle" as used in the metal-working industries, giving various applications, and describing the difference in practice prevailing among the users of the pickling operation. 4500 w. Elec Chem & Met Ind—Sept., 1905. No. 72093 C.

Castner Process.

The Castner Mercury Process for Producing Chlorine and Alkali (Das Quecksilberverfahren von Castner zur Gewinnung von Chlor und Alkali). M. Le Blanc. Laboratory experiments of Dr. Carlo Cantoni, at the Karlsruhe Technische Hochschule, with illustrations and tables. 1500 w. Zeitschr f Elektrochemie—Sept. 8, 1905. No. 72131 G.

Diamonds.

See Mining and Metallurgy, Miscellany.

Electrolysis.

Alternate-Current Electrolysis. Ernest Wilson. Abstract of paper before the Faraday Society, giving account of experiments with various metals and electrolytes, with table and curves. 2000 w. Elec'n, Lond—Sept. 8, 1905. No. 71753 A.

Alternate Current Electrolysis. Prof. Ernest Wilson. Read before the Faraday Society. An account of experiments made to determine what may be the effect upon certain metals of passing alternating currents between them and certain electrolytes under given conditions. 2800 w. Elec Engr, Lond—Sept. 15, 1905. No. 72081 A.

Gas Cell.

The Generator Gas Cell and the Carbon Cell (Das Generatorgas und das Kohlenelement). F. Haber and A. Moser. Description of laboratory experiments and results with gas batteries having the electrolyte of hot glass, and electrodes of carbon dioxide, carbonic oxide, oxygen and other gases. 7000 w. Zeitschr f Elektrochemie—Sept. 8, 1905. No. 72130 G.

Heroult Process.

The Heroult Process (Der Prozess Héroult). Illustrated description of electric furnace and process for the production of iron and steel. Serial. Part 1. 700 w. Elektrochem Zeitschr—Sept., 1905. No. 72133 G.

Nitrogen.

Utilization of Atmospheric Nitrogen (Utilisation de l'Azote Atmosphérique). A. Boileau. Description, with illustrations of electrical methods and apparatus for obtaining nitrogen and nitrogen compounds from the air. 4000 w. Génie Civ—Sept. 2, 1905. No. 72139 D.

Experiments on the Production of Oxides of Nitrogen by Means of High Voltage. Discharges in Air (Versuche über die Darstellung von Oxyden des Stickstoffs durch Hochspannungsentladungen in Luft). Otto Scheuer. Description of apparatus and results of experiments at the Darmstadt Technische Hochschule, with curves, diagrams and tables. 4500 w. Zeitschr f Elektrochemie—Sept. 1, 1905. No. 72129 G.

Tin Refining.

The Electric Separation and Refining of Tin by Means of Fluoric and Fluosilicic Acids (Elektrische Zinnewinnung und Zinnraffination mit Fluss und Kieselflusssäure). Hans Mennicke. Discussion of the Betts and other processes. Serial. Part 1. 1500 w. Elektrochem Zeitschr—Sept., 1905. No. 72132 G.

ELECTRO-PHYSICS.

Matter.

Evolution of Inanimate Matter. Prof. G. H. Darwin. Excerpt from the presidential address before the British Assoc. giving a review of the modern theory of matter and atoms. 2500 w. Elec Rev, N Y—Sept. 2, 1905. No. 71716.

Radioactivity.

The Electrical Nature of Matter and Radioactivity. Harry C. Jones. The first of a series of articles giving an account of the most recent developments in physical science. 2000 w. Serial. 1st Part. Elec Rev, N Y—Sept. 9, 1905. No. 71723.

Radium.

The Production of Radium from Uranium. Bertram B. Boltwood. Discusses the experiments described by Mr. Soddy in three different papers, and describes experiments by the writer. 1800 w. Am Jour of Sci—Sept., 1905. No. 72029 D.

Reluctance.

An Experimental Determination of Air-Gap Reluctance. Charles H. Smoot. Aims to give a practical method of solving problems concerning magnetic reluctance and distribution. Ills. Discus-

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sion. 4000 w. Jour W Soc of Engrs—Aug., 1905. No. 71988 D.

GENERATING STATIONS.

Accumulators.

Accumulators with Reversible Boosters for Factory Installations. Ralph W. Birkett. An account of the writer's experience with a generating plant recently erected and managed by him in a large engineering works, showing that a battery thus equipped effects substantial economies in running expenses, and possesses other advantages. 4000 w. Serial. 2 parts. No. 71765 each A.

Acyclic Dynamo.

The Acyclic Dynamo of J. E. Noeggerath (Die Azyklische Maschine von J. E. Noeggerath). Clarence Feldmann. Illustrated description of the homopolar dynamo, a form of unipolar machine, invented by Noeggerath and developed by the General Electric Co. 1809 w. Elektrotech Zeitschr—Sept. 7, 1905. No. 72156 B.

Birmingham University.

Birmingham University Power Station. C. Alfred Smith. Illustrates and describes the equipment of this station which has been in successful operation for more than a year. 2200 w. Elec Rev, Lond—Aug. 25, 1905. No. 71764 A.

Bournillon.

The Hydraulic Plant of Bournillon, France. C. L. Durand. Illustrates and describes a recently erected large plant on the Bourne River, and its equipment. 2800 w. Elec Rev, N Y—Sept. 16, 1905. No. 72090.

Brooklyn.

The New Williamsburg Power Plant of the Brooklyn Rapid Transit Company. Describes the general arrangement of this new fireproof station, its boilers, forced draft, flues and stacks, coal and ash handling machinery, piping, pumps and heaters, turbines, electrical distribution, etc. Ills. 5600 w. St Ry Jour—Sept. 23, 1905. No. 72235 C.

New Power Plant of the Brooklyn Rapid Transit Company. Illustrated detailed description of the new Williamsburg station now under construction on the Wallabout Canal. 3200 w. Elec Wld & Engr—Sept. 23, 1905. No. 72214.

Bruck.

Hydro-Electric Plant of the City of Bruck, Austria. Franz Koester. Illustrated description of light and power station with capacity of 2700 horse-power. 800 w. Elec Rev, N Y—Sept. 2, 1905. No. 71719.

Commutators.

The Maintenance of Commutators and Brushes. S. Lees. An illustrated article discussing in the present number, the methods of truing up commutators. 3700 w. Elec Engr, Lond—Aug. 25, and Sept. 1, 1905. Serial. 2 parts. No. 71756 each A.

Electricity Supply.

The Supply of Electricity in Industrial Areas from a Municipal Point of View. William Hodgson. Read before the Incor. Munic. Elec. Assn., at Edinburgh. Remarks on present conditions and the demand for electric power, and the factors demanding municipal attention. 2200 w. Prac Engr—Aug 25, 1905. No. 71670 A.

Europe.

European Vertical Turbine Hydro-Electric Plants. Frank C. Perkins. Brief illustrated descriptions of the Brugg, Interlaken and Luterbach-Solothurn water-power installations. 1000 w. Mod Mach—Sept., 1905. No. 71685.

Erith.

See Street and Electric Railways.

Fife.

The Fife Electric Power Co.'s Station. Illustrated description of moderate size electric station near Dumfermline, Scotland. 800 w. Elect'n, Lond—Sept. 8, 1905. No. 71751 A.

The Fife Electric Power Company. Illustrates and describes particulars of the work which has been accomplished in the development of power supply in the country of Fife. 1800 w. Elec Engr, Lond—Sept. 1, 1905. No. 71758 A.

Framingham, Mass.

Power Plant of the Boston and Worcester Street Railway. Describes and illustrates a plant that operates an electric interurban system about 40 miles long. 1700 w. Ir. Age—Aug. 31, 1905. No. 71870.

Hamburg.

The Stations of the Hamburg Electric Works (Die Anlagen der Hamburgischen Elektrizitätswerke). Max Rupprecht. Fully illustrated descriptions of stations and substations. Direct current and storage batteries are used. Serial. Part 1. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72100 D.

Hanover.

The Municipal Central Power Station of Hanover, Germany. Illustrated description of a new alternating current plant and the features of special interest. 2800 w. Power—Oct., 1905. No. 72242 C.

Hartford.

The New Station of the Hartford Electric Light Company. Well illustrated description of the 5500 kw. plant at Dutch Point, Conn., equipped with Westinghouse-Parsons steam turbines to supplement the company's water-power plants.

We supply copies of these articles. See page 319.

2500 w. Elec Rev, N Y—Sept. 9, 1905. No. 71725.

History.

The Development of Electric Machines (Die Entwickelung der Elektrischen Maschinen). F. Tischendörfer. Paper before the Elektrotechnische Verein, giving a general historical review of the evolution of dynamos and electric motors and their design. Illus. 8000 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72152 B.

Incinerating Plant.

See Civil Engineering, Municipal.

Italy.

Hydro-Electric Plants in Upper Italy (Les Installations Hydro-Electriques de la Haute Italie). G. Semenza. Illustrated general description of stations and transmission lines in Northern Italy. 3 Plates. 10000 w. Mem Soc Ing Civils de France—Aug., 1905. No. 72182 G.

Linthal.

The Electric Station at Linthal, Switzerland (Das Elektrizitätswerk Linthal). Description, with illustrations and maps, of a small hydro-electric plant, with a high head of water, and generating three phase current. 2000 w. Schweiz Bauzeitung—Aug 26, 1905. No. 72117 D.

New York Edison.

Waterside Station No. 2 of the New York Edison Company. Well illustrated description of light and power station with 7500 and 8000 kw. turbo generators, with ultimate capacity of over 100,000 horse-power. 4500 w. Serial. 2 parts. Elec Wld & Engr. Sept. 2 and 9, 1905. No. 71708.

The New Waterside Station of the New York Edison Co. Illustrated detailed description of a turbine driven plant known as "Waterside Station No. 2." 3500 w. Eng Rec—Sept. 9, 1905. No. 71895.

Norway.

A Norwegian Hydro-Electric Power Plant. Dr. Alfred Gradenwitz. Illustrated description of the Kykkelsrud power station, on the Glommen River. 1400 w. Elec Rev, Lond—Sept. 8, 1905. No. 71770 A.

Organization.

The Organization of Working Forces in Large Power-Houses. W. P. Hancock. Gives an outline of the generating department organization of the Boston Edison Company. Also editorial. 6800 w. Cent Sta—Sept., 1905. No. 71980.

Philadelphia.

Power Plant Improvements of the Philadelphia Rapid Transit System. Illustrates and describes the Wyoming Ave. station, and the steam turbine Delaware Ave. station, and their equipment. 3000 w. Eng Rec—Sept. 23, 1905. No. 72223.

Power Equipment of the Philadelphia Rapid Transit Co. Illustrated descriptions of the direct-current stations, and the alternating-current station, sub-stations, and their equipment. 5800 w. St Ry Rev—Sept., 1905. No. 72219 C.

Glenside Sub-Station. Illustrates and describes this new rotary converter substation of the Philadelphia Rapid Transit Co. 3000 w. St Ry Rev—Sept. 15, 1905. No. 72221 C.

Puget Sound.

The Hydraulic Plant of the Puget Sound Power Company. Discussion of paper by Edwin H. Warner, printed in May *Proceedings*. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1905. No. 72292 E.

Saut Mortier.

The Saut Mortier Transmission Plant. F. M. Bryan. Illustrated description of a 3000 horse-power hydro-electric plant in the Jura region of France, which transmits current to a great many small towns and villages. 2500 w. Am Electr'n—Sept., 1905. No. 71734.

Small Stations.

Combination and Operation of Small Central Station Plants. Abstract of a paper by Cleon L. Williams on "Erection and Maintenance of Electric Lighting Plants," before the International Association of Municipal Electricians. 2000 w. Elec Wld & Engr—Sept. 9, 1905. No. 71714.

Turbo-Dynamos.

Turbo-Dynamos (Turbodynamos). Prof. F. Niethammer. Address before the "Oesterr Vereinigung der Elektrizitätswerke", giving an illustrated review of the present constructions of dynamos for direct connection to steam turbines. 3000 w. Zeitschr f Elektrotech—Aug. 20, 1905. No. 72161 D.

Utah.

The Electric Light and Power Plant of Brigham City, Utah. W. P. Hardesty. Illustrated detailed description of a municipal light and power plant erected in 1902 and 1903. Describes the equipment and gives information of the service and low cost of power. 3200 w. Eng News. Sept. 7, 1905. No. 72038.

Walthamstow.

The Walthamstow Electric Lighting and Tramways Undertakings. Illustrated description of a new traction and lighting plant in which the energy is supplied from gas-driven plant, supplementary to the original installation. This is the largest gas-driven plant in England. 1500 w. Elec Rev, Lond—Sept. 15, 1905. No. 72084 A.

We supply copies of these articles. See page 319.

Welland Canal.

Electric Power from Welland Canal. Alton D. Adams. Describes the plant of the Hamilton Cataract Power, Light and Traction Co., Ltd., and discusses the possibilities of power development on this canal between Lakes Erie and Ontario, with a drop of 327 feet. 2000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71718.

Willimantic.

The Electrical Equipment of the American Thread Company. Geo. A. Burnham. Description, with illustrations, of hydro-electric plant and distribution system at the Willimantic Mills, Conn. 1200 w. Am Electr'n—Sept., 1905. No. 71737.

Yorkshire.

The Yorkshire Electric Power Co.'s System of Generation and Distribution. Well illustrated detailed description of present condition of this undertaking, particularly of power station just completed at Thornhill, near Leeds. Serial. 1st part. 2000 w. Elect'n, Lond—Sept. 1, 1905. No. 71745 A.

The Yorkshire Electric Power Company. An illustrated description of a station for the supply of power, and its equipment. 2800 w. Elec Engr, Lond—Sept. 8, 1905. No. 71759 A.

LIGHTING.

Arc Lamps.

Comparison of Arc Lamps and Arc Lamp Systems in Relation to Economy (Vergleich der Verschiedenen Bogenlampenarten und Bogenlampenschaltungen in Bezug auf Ihre Wirtschaftlichkeit). Fritz Hoppe. Practical study of commercial types of arc lamps, with curves and tables. 3000 w. Elektrotech Zeitschr—Sept. 7, 1905. No. 72157 B.

Arcs.

The Dynamics of the Electric Arc and Arc Hysteresis (Ueber die Dynamik der Lichtbagenvorgönge und über Lichtbogenhysteresis). Herm. Th. Simon. Reprint from the *Physikalische Zeitschrift*, giving a comprehensive study of arc phenomena, with curves and diagrams. Serial. 2 parts. 9000 w. Elektrotech Zeitschr—Aug. 31, 1905. No. 72155 B.

Stroboscopic Observations of Alternating Current Arcs. Gives photographs, and describes methods used by Messrs. L. Lombardi and G. Melazzo in an experimental study. 1200 w. Sci Am Sup—Sept. 9, 1905. No. 71840.

Illumination.

The Distribution of Illumination in Artificially Lighted Spaces (Ueber die Helligkeitsverteilung in Künstlich Beleuchteten Räumen). F. Meisel. Theoretical discussion, with formulæ and diagrams. 2500 w. Elektrotech Zeitschr—Sept. 14, 1905. No. 72159 B.

Lamp Tests.

Efficiency of Incandescent Lamps. Abstract of paper by M. M. Lauriol and P. Janet before the Société Internationale des Electricians describing results of comparative tests on 110 and 220-volt lamps, with curves and tables. 1000 w. Elect'n, Lond—Sept. 1, 1905. No. 71747 A.

Municipal Lighting.

Municipal Electric Lighting. J. W. Wood. Read before the League of Am. Municipalities at Toledo, O. An account of what has been accomplished in this field in St. Louis, Mo. 3800 w. Munic Jour & Engr—Sept., 1905. No. 71690 C.

St. Louis Municipal Lighting. Joseph W. Wood. An account of conditions and cost by private companies and by municipal plant, showing a great saving by the latter. 2500 w. Munic Eng—Sept., 1905. No. 71943 C.

Tantalum Lamp.

Tests of the Tantalum Lamp. Abstract of paper by Prof. Wm. Ambler before the Ohio Electrical Association, with curves. 1500 w. Elec Wld & Engr—Sept. 2, 1905. No. 71711.

MEASUREMENT.

Condenser.

An Adjustable Condenser. Clyde C. Swayne. Illustrated description of brass plate, air-insulated condenser for wireless telegraphy and other high-potential work. 600 w. Am Electr'n—Sept., 1905. No. 71740.

Friction Losses.

See Mechanical Engineering, Measurement.

Insulation.

Insulation Testing. C. E. Skinner. Read before the Nat. Elec. Lgt. Assn. An illustrated article discussing the elements that should be considered in the design, selection and use of apparatus for making dielectric tests. 2400 w. Elec Jour—Sept., 1905. Serial. 1st part. No. 72031.

The Testing of High-Tension Insulating Materials. C. Kinzbrunner. An account of very complete experiments made at the Municipal School of Technology, Manchester, with curves and diagrams. Serial. Part 1. 2500 w. Elect'n, Lond—Sept. 8, 1905. No. 71750 A.

Meters.

Practical Information on Central Station Meters. Synopsis of questions and answers from the "Question Box" of the National Electric Light Association. 2000 w. Elec Wld & Engr—Sept. 2, 1905. No. 71710.

We supply copies of these articles. See page 319.

Motor Testing.

The Eddy Current Brake for Testing Motors. D. K. Morris, and G. A. Lister. The present number reviews the methods of motor-testing in use, presents the advantages of Eddy-current brakes, giving detailed description of new design and some results obtained. Illus. 2000 w. Elec Engr, Lond—Sept. 15, 1905. Serial. 1st part. No. 72082 A.

Standards.

Practical Standards for Electrical Measurements. Report of the committee of the British Association, recently presented in South Africa, on experiments for improving the construction of practical standards for electrical measurements. 4000 w. Elec Engr, Lond—Aug. 25, 1905. No. 71757 A.

MOTORS.

Air Compressor.

See Mechanical Engineering, Power and Transmission.

Applications.

Electric Motor Applications. J. Henry Klinck. Read before the Ohio Elec. Lgt. Assn. Illustrates numerous applications, discussing the conditions and methods applicable to each. 2000 w. Elec Jour—Sept., 1905. No. 72033.

Alternating.

The Operation of Alternating-Current Motors on the System of an Electric Light Plant of 1000 Kilowatts or Less Capacity. E. H. Beil. Abstract of paper before Ohio Electric Light Assoc. 800 w. Elec Rev, N Y—Sept. 2, 1905. No. 71717.

Induction Motors.

Measurement of the Slip of Induction Motors. C. V. Drysdale. Discussion of various methods, with illustrated description of some modifications of the stroboscopic method. 2400 w. Elect'n, Lond—Aug. 25, 1905. No. 71743 A.

Notes on the Induction Motor as Generator. T. P. E. Butt. Abstract of paper before the South African Association of Engineers, giving account of experiments in which the rotor of a 300 horse-power induction motor was supplied with direct current and rotated by a steam engine. 2000 w. Elect'n, Lond—Aug. 25, 1905. No. 71744 A.

Some Points About the Induction Motor. J. W. Welsh. Considers the effect of variation in the supply circuit. 1500 w. Elec Jour—Sept., 1905. No. 72032.

The Induction Motor Leakage Coefficient. A Press. Mathematical development of formula, with diagram, and comparison with other formulæ. 800 w. Elec Wld & Engr—Sept. 9, 1905. No. 71715.

Mining Machinery.

See Mining and Metallurgy, Mining.

Motor Rating.

Motor-Rating Diagram. C. P. Nachod. Outlines a convenient method of expressing the characteristics of a complete line of motors of one type, but of various speeds and outputs. 500 w. Elec Wld & Engr—Sept. 16, 1905. No. 72092.

Polyphase.

The Design of Polyphase Motors (Zur Berechnung von Drehstrommotoren). J. K. Sumec. Comprehensive discussion of the calculations with formulæ and diagrams. 4000 w. Zeitschr f Elektrotech—Aug. 27, 1905. No. 72162 D.

Single-Phase.

Latest Developments in Single-Phase Motors for Commercial Power Purposes. W. A. Layman. Read before the Pacific Coast Engng. Cong. Considers in some detail the developments being made in variable speed motors. 2200 w. Jour of Elec—Sept., 1905. No. 72097 C.

The Westinghouse Single-Phase Railway Motor (Der Einphasige Bahnmotor der Westinghouse-Gesellschaft). Clarence Feldmann. Illustrated description, with curves. 500 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1905. No. 72125 D.

Starting Switch.

See Electrical Engineering, Distribution.

TRANSMISSION.

Alternating Currents.

The Transmission of Power by Alternating Currents. Alfred Still. Considers single-phase, two-phase and three-phase transmission, and the points to be borne in mind when considering a scheme of power transmission to a distance by means of alternating currents. 3000 w. Elec Engr, Lond—Sept. 15, 1905. Serial. 1st part. No. 72080 A.

High-Voltage.

High-Voltage Power Transmission. Clarence P. Fowler. Discussion of the general question and of conductors, insulators and pole line. 1500 w. Am Electr'n—Sept., 1905. No. 71736.

Pole Lines.

Line Construction. B. L. Chase. Abstract of paper before the Ohio Electric Light Assoc., discussing poles, cross arms, insulators, pins, etc., for high-voltage lines. 1200 w. Elec Rev, N Y—Sept. 9, 1905. No. 71726.

Wire Spacing.

The Spacing of the Wires on High-Pressure Power Lines. W. B. Esson. Discusses this subject briefly and proposes that a uniform standard spacing be

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adopted of 1 ft. for every 10,000 volts pressure with a minimum spacing of 2 ft. 900 w. Elec Rev, Lond—Sept. 1, 1905. No. 71767 A.

MISCELLANY.

Costs.

Actual Cost of Energy Used in Driving a Small Engineering Works. Gives particulars supplied by a firm of engineers in Lancashire. 500 w. Elec Rev, Lond—Sept. 1, 1905. No. 71768 A.

Electromagnets.

Alternating-Current Electromagnets. Charles R. Underhill. Discussion of operation, with account of tests, and curves and illustrations. 1200 w. Am Electr'n—Sept., 1905. No. 71738.

Japan.

The Electrical Outlook in Japan. A review of the present condition of electrical matters bearing upon trade. 3300 w. Elec. Rev, Lond—Sept. 8, 1905. No. 71769 A.

Paris.

Electricity in Paris. An explanation of the action of the Paris Municipal Council and the results. 2000 w. Engng—Sept. 8, 1905. No. 71791 A.

Rates.

Maximum Demand. J. S. Codman. Discusses the best method of determining the demand in this system of charging for electric light. 2000 w. Elec Wld & Engr—Sept. 23, 1905. No. 72216.

Regulation of Electric Rates in Massachusetts. Alton D. Adams. A series of digests of the leading decisions of the Massachusetts Gas and Electric Commission. 2500 w. Serial. 1st part. Elec Wld & Engr—Sept. 2, 1905. No. 71709.

Standards.

Theory and Practice. E. A. N. Pochin. A criticism of statements, given by eminent professors, explaining the unreliability found in the information sought. 1200 w. Elec Rev, Lond—Sept. 1, 1905. No. 71766 A.

INDUSTRIAL ECONOMY

Accounting.

Accounting.—An Influence Towards Lessening Costs and Increased Efficiency. Kenneth Falconer. Read at the A. F. A. convention. Suggestions for planning methods of accounting. 1200 w. Foundry—Sept., 1905. No. 72270.

Birmingham University.

The Birmingham University. An account of the history of this enterprise with illustrated description of the buildings is given in the present number. 3500 w. Engng—Aug. 25, 1905. Serial. 1st part. No. 71771 A.

Canals.

The Inferiority of Canals as a Means of Goods Transport. Daniel Bellet. Discusses the canals of France and the conditions that made the work less costly than the usual construction of artificial waterways, and claims that such transportation is out of date, inefficient, and not cheap. 2700 w. Engng—Sept. 15, 1905. No. 72070 A.

China.

Chinese Concessions. Charles D. Jameson. Discusses the opposition to concessions for railways or mines to foreign syndicates and the reasons. 2800 w. Eng & Min Jour—Sept. 9, 1905. No. 71886.

Cost-Keeping.

Brass-Foundry Records and Costs. H. Deighton. General discussion, with forms for a moderate-sized foundry. 2000 w. Eng Mag—Oct., 1905. No. 71704 B.

Cost-Keeping. Dr. Edward Kirk. Does not consider the card system of much value in the foundry. 1800 w. Foundry. Sept., 1905. No. 72272.

Labor.

The Eight-Hour Day. R. W. Raymond. A discussion of the demands Mr. John Mitchell announces that he intends to present next April in behalf of the Mine Workers' Union. 1700 w. Eng & Min Jour—Sept. 9, 1905. No. 71885.

Liége Exposition.

The Mechanical Features of the International Exposition at Liége. Léon Ramakers. Illustrated description of the mining, metallurgical, railway and other mechanical and engineering exhibits. 2000 w. Eng Mag—Oct., 1905. No. 71705 B.

Organization.

The "Get Together" Principle in a Factory Organization. H. F. J. Porter. Remarks on the benefits from a conference of the employees, giving example, suggestions, etc. 3500 w. Am Mach—Vol. 28. No. 39. No. 72277.

Output Restriction.

The Restriction of Output. Abstract of a chapter in the report of the Bureau of Labor upon the restriction of output in the manufacturing trades, especially deal-

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ing with that regulation of output by the machinists' organizations. 4000 w. Ir Age —Aug. 31, 1905. No. 71871.

Pacific Coast.

Problems that Confront Engineering and Kindred Industries on the Pacific Coast. George W. Dickie. Read before the Pacific Coast Engng. Cong. Explains conditions and discusses cost of materials, cost of labor and other economic problems. 5500 w. Jour of Elec—Sept. 1905. No. 72096 C.

Valuation.

The Determination of Physical Values. Clinton S. Burns. Presents a method for the determination of valuations which it is believed is founded upon correct economics. 2500 w. Eng Rec—Sept. 16, 1905. No. 71973.

Works Management.

The Truce Between Capital and Labor. Carroll T. Fugitt. An illustrated article describing what has been accomplished at the National Cash Register factory, in Dayton, Ohio, to advance the health, happiness, and welfare of the employees. 4000 w. Cassier's Mag—Sept., 1905. No. 72251 B.

MARINE AND NAVAL ENGINEERING

Battleship.

A Government-Built Battleship. Illustration of the "Connecticut," now under construction at the Brooklyn navy yard, with a report of the creditable work, and the influence on private shipyards. 1000 w. Sci Am—Sept. 23, 1905. No. 72204.

Benningon Explosion.

Official Report of the Gunboat Bennington Explosion. Report of the court of inquiry which investigated the accident. Also editorial. 2500 w. Naut Gaz —Aug. 31, 1905. No. 71698.

Boilers.

See Mechanical Engineering, Steam Engineering.

Coal Endurance.

A Method of Calculating the Coal Endurance and Steaming Radius of War Vessels under Various Conditions. B. C. Bryan. Presents a method of tabulating and using data collected. 2200 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71998 H.

Cruisers.

U. S. S. Charleston. M. E. Reed. Description and report of official trial. Ills. 15700 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72004 H.

The U. S. S. Galveston. General description, with report of standardization, official, and endurance trials. 2000 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71997 H.

Dry Docks.

Tests of the Cavite Steel Floating Dry Dock. A. C. Cunningham. An illustrated report of the docking tests of the "Dewey" dock. 1300 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72000 H.

The Self-Docking Tests of the Steel Floating Dry Dock for Cavite, P. I. Leonard M. Cox. An illustrated account of the self-docking operations. 2000 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72001 H.

"Fathomer."

U. S. Coast and Geodetic Survey Steamer "Fathomer" for Philippine Service. G. R. Putnam. Illustrations, with a brief outline of the principal features of interest from an engineering point of view. 1000 w. Eng News—Sept. 28, 1905. No. 72278.

Float.

Drouillard's Drifter Balloon Float. Describes a simple and practical apparatus designed to carry a line between a vessel in distress and the shore. 900 w. Sci Am—Sept. 16, 1905. No. 71901.

German Shipbuilding.

The Development of the German Shipbuilding Industry (Die Entwickelung der Deutschen Schiffbauindustrie). Hr. Stellter. Paper before the Schleswig-Holstein branch, giving history and statistics, with curves and table. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72104 D.

Gunboats.

U. S. Gunboats Dubuque and Paducah. W. N. Little. Illustration with description of the vessels, their equipment, and armament, and report of trials. 10500 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71995 H.

Gyroscope.

Anschütz Gyroscope. Describes the invention of Dr. H. Anschütz-Kämpfe and its working. Also reports tests made by the Imperial German navy department, and states cases in which its use is of

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advantage. Ills. 2400 w. U S Cons Repts—June, 1905. No. 72018 D.

Japan.

The Dockyards and Ship-Building Plants of Japan. Chas. Albertson. The second part of this review, dealing with the private establishments for ship-building and repair work, with illustrations and a map. 4500 w. Engineering Magazine—October, 1905. No. 71703 B.

Lighthouses.

The Gibbs' Hill Lighthouse, Bermuda. Robert A. Cummings, and C. W. Reinhardt. Illustrates and describes the modern lenses and apparatus recently installed in the Gibbs' Hill lighthouse. 1000 w. Eng News—Aug. 31, 1905. No. 72025.

Modern Lighthouse Illumination. James Shirra. Read before the Engng. Assn. of N. S. W. Discusses recent practice in this field both as regards the light and methods of securing far-reaching power. 5200 w. Aust Min Stand—Aug. 2, and 9, 1905. Two parts. No. 71962 each B.

See also Civil Engineering, Construction.

Motor Yacht.

Suction - Producer - Gas - Motor Yacht "Emil Capitaine." General description, with illustrations, of an interesting gas engine and producer for marine propulsion. 1500 w. Prac Engr—Sept. 15, 1905. No. 72079 A.

Propellers.

A Comparison of the Performances of Propellers, U. S. S. Wyoming. Gives a comparison of the performances of the vessel with the original propellers and with a spare set built to conform to specifications furnished by the Bureau. Ills. 1300 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71999 H.

The Dynamics of Screw Propellers. Prof. Robert H. Smith. Comments on recent articles, with a suggestion for an improvement in construction, claiming that the scientific mechanics of ship propulsion points clearly toward some form of jet propulsion. 5000 w. Engr, Lond—Sept. 1, 1905. No. 72006 A.

Salvage.

The Refloating of Ships (Le Renflouement des Navires). H. Pierron. An account of the refloating and salvage of wrecked ships, particularly of the "Chili," sunk near Bordeaux. 2000 w. Rev Tech—June 10, 1905. No. 72143 D.

Shear Legs.

180-Ton Shear Legs for the British Naval Dockyard. Illustration, with description, of the largest shear legs in the world, erected at the dockyard at Chatham. 700 w. Sci Am—Sept. 30, 1905. No. 72287.

Signalling.

Submarine Signalling. Reviews what has been done in this field, and gives an illustrated description of the apparatus devised for this purpose by the Submarine Signal Co., of Boston. Gives details of trials and other information. 2800 w. Engr, Lond—Sept. 1, 1905. No. 72010 A.

Steam Turbines.

See Mechanical Engineering, Steam.

Superheating.

See Mechanical Engineering, Steam.

Turbine Steamer.

The Turbine-Propelled British Coasting Steamer Dieppe. Illustrated description of the turbine machinery and its arrangement, with information concerning the vessel, and report of official trial. 2000 w. Naut Gaz—Sept. 14, 1905. No. 71920.

Vibration.

Vibration Phenomena of Steamships (Vibrationserscheinungen der Dampfer). Otto Schlick. General review of the present state of knowledge of ship and engine vibrations, and their remedies. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1905. No. 72123 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Beaufort.

The Beaufort Cars. Illustrates and describes the special features of these cars, such as the accessible magnets, igniters, ball-bearings to transmission and wheel axles, and three-point cantilever suspension to gear-box. 1000 w. Autocar—Aug. 26, 1905. No. 71663 A.

Clutches.

New Clutches Exhibited at the Paris Automobile Salon, in December, 1904 (Les Embrayages Nouveaux Exposés au Salon de Decembre 1904). H. André. Illustrations and descriptions of automobile clutches and gears. Serial. Part I. 1200 w. Rev Tech—June 10, 1905. No. 72147 D.

Commercial Vehicles.

Competition of Commercial Automobiles and Military Auto Trucks (Concours de Véhicules Industriels et de Fourgons Militaires). Ch. Dantin. Illustrated de-

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scription of automobile trucks, omnibuses, delivery wagons, etc., in road competition under auspices of the Automobile Club of France and the French Department of War. Serial. 3 Parts. 7000 w. Génie Civ—Sept. 2, 9 and 16, 1905. No. 72138 each D.

The Atlas Gasoline Commercial Truck. Illustrates and describes the constructional features of interest. 2300 w. Automobile—Aug. 31, 1905. No. 71688.

Knox 6,000 Pound Air-Cooled Truck. Brief illustrated description of a machine for a heavy class of work. 800 w. Automobile—Sept. 14, 1905. No. 71905.

Dust.

Cause and Prevention of Dust from Automobiles. W. R. Cooper. Considers what has been accomplished in the special treatment of roads, and discusses the effect of the design of the car, and means of checking the dust. Ills. 4300 w. Nature—Sept. 14, 1905. No. 72017 A.

Fire-Engines.

"Merryweather" Self-Propelled Fire-Engines. Illustrations, with brief description. 500 w. Auto Jour—Sept. 9, 1905. No. 71956 A.

Lubricator.

The Albion Lubricator. Illustrated description of the mechanical lubricator on the Albion car. It is a multiple-feed lubricator, occupying very small space. 1000 w. Auto Jour—Sept. 16, 1905. No. 72075 A.

Manograph.

The Manograph—Its Utility and Construction. Illustrated detailed description of an apparatus for producing diagrams which enable the internal action of an engine to be seen. 1200 w. Auto Jour—Sept. 16, 1905. Serial. 1st part. No. 72076 A.

Omnibuses.

Electric Automotor Omnibuses. H. E. P. Cottrell. An illustrated series of articles considering what has been accomplished on the Continent, especially in France, to supply facilities of transportation of this character, their efficiency and cost. 3500 w. Engr, Lond—Sept. 1, 1905. Serial. 1st part. No. 72007 A.

Petrol Gauge.

The Murphy Petrol Gauge. Drawings and description of an apparatus for accurately indicating the amount of petrol in the tank of a motor vehicle. 900 w. Autocar—Sept. 16, 1904. No. 72077 A.

Pope-Tribune.

The Two-Cylinder 10 H. P. Pope-Tribune Car. Illustration, with detailed description of a light touring car. 1100 w. Autocar—Sept. 16, 1905. No. 72078 A.

Richard-Brasier.

The 40-50-H. P. Richard-Brasier Car. Illustrated detailed description of an extremely powerful touring model. 1600 w. Auto Jour—Aug. 26, 1905. Serial. 1st part. No. 71664 A.

Smoke.

The Cause and Prevention of Smoke on Motor Cars. Edward Butler. Considers the trouble due mainly to the faulty methods in use for lubricating the cylinders of the explosion motor. 900 w. Mech Engr—Sept. 9, 1905. No. 71960 A.

Street Sweeper.

Auto Street Sweeper. Brief illustrated description of a machine on trial in Paris. 300 w. Automobile—Sept. 28, 1905. No. 72286.

Waltham Car.

Orient 16-20 H. P. Air-Cooled Model de Luxe. Illustrated description of the 1905 model of the Waltham Mfg. Co. 1400 w. Automobile—Sept. 21, 1905. No. 72095.

COMBUSTION MOTORS.

Compression.

The Effect of Hydrogen on Gas Engine Compression. George M. S. Tait. Discusses the advantages gained by high compression in gas engines, and the necessity of putting the compression much lower to prevent pre-ignitions when hydrogen is present, and refers to a new system in which steam is replaced by cooled exhaust gases. 1200 w. Sci Am—Sept. 23, 1905. No. 72202.

Diesel Motor.

500-Horse-Power Diesel Motor, with Three Cylinders, at the Liége Exposition (Moteur Diesel de 500 Chevaux à Trois Cylindres, Installé à l'Exposition de Liége). Illustrated description. 1 Plate. 1000 w. Génie Civ—Sept. 9, 1905. No. 72141 D.

Economy.

Is Gas Power More Economical Than Water Power? H. G. T. Horace. Presents an analysis of costs aiming to show that gas power can be produced more economically. 1600 w. Power—Oct., 1905. No. 72244 C.

Electric Auxiliaries.

Utilization of Gas Engines in Connection with Long Distance Electric Transmission. J. Martin. Read before the Pacific Coast Gas Assn. Describes large gas engines to be used in California, for the generation of electricity in times of emergency on long distance transmission lines. Discussion. 5500 w. Am Gas Lgt Jour—Sept. 18, 1905. No. 71910.

We supply copies of these articles. See page 319.

Gas-Producers.

Economy of Gas-Producer Power Plants Where Heating is Necessary. J. H. Kinealy. A comparison of the fuel consumption of gas-producer plant and both non-condensing, and condensing steam plants. 2500 w. Eng News—Sept. 7, 1905. No. 72041.

Gas-Producer for Semi-Bituminous Fuel at the Liége Exhibition. Illustrates and describes an installation consisting of a double-combustion producer, of sufficient capacity to supply a 600-H. P. gas-engine, with a complete washing and cleaning plant, and a 60 cubic metre gas-holder. 1200 w. Engng—Aug. 25, 1905. No. 71777 A.

Lignite and Peat Gas Producers for Power Purposes (Braunkohlen- und Torfgeneratoren für Motorische Zwecke). Arnold Zlamal. Paper before the "Oesterr. Vereinigung der Elektrizitätswerke," giving a general discussion of such producers, with illustrated description of a couple of types. 1600 w. Zeitschr f Elektrotech—Sept. 3, 1905. No. 72163 D.

Suction Gas Producer Plants. Dr. Oskar Nagel. Explains the working of suction gas producer plants, and their advantages over the pressure gas producers. Ills. 2500 w. Cassier's Mag—Sept., 1905 No. 72255 B.

Gas Turbine.

Crossley and Atkinson's Turbine for Combustible Gases. Illustrated description of a recent patent. 1300 w. Mech Engr—Sept. 9, 1905. No. 71959 A.

Governing.

Governing of Gas and Oil Engines. Brief discussion of the merits of the several systems. 1000 w. Prac Engr—Sept. 8, 1905. No. 71957 A.

Liége Exposition.

Prime Movers at the International Exposition at Liége, 1905 (Bemerkenswerte Kraftmaschinen auf der Weltausstellung zu Lüttich 1905). H. Dubbel. Well illustrated descriptions of gas engines, with some account of steam turbines and reciprocating steam engines. Serial. Part I. 3 Plates. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72105 D.

Manograph.

See Mechanical Engineering, Automobiles.

Physico-Chemical.

Physico-Chemical Aspects of the Process of Combustion in Gas Engines (Physikalisch-Chemische Betrachtungen über den Verbrennungsprozess in den Gasmotoren). Prof. W. Nernst. Paper before the Verein deutscher Ingenieure, discussing thermodynamics and other theoretical aspects of internal-combustion motors. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72106 D.

Producer-Gas Engine.

300-Brake-Horse-Power Rowden Producer Gas Engine. Illustrates and describes the arrangement and details of a new type of engine for producer-gas. It is of the two-crank vertical type with four cylinders, two working in tandem on each crank. 2800 w. Engng—Sept. 15, 1905. No. 72069 A.

Wood Gas.

Wood-Gas for Power Purposes and Gas-Generators. George M. Douglas. Read before the Inst. of Min. & Met. Describes the power plant for the concentrating works and mine of the Montezuma Copper Company, located at Nacozari, Sonora, Mexico, giving results of making of water gas with wood for fuel. 2800 w. Ills. Engng—Sept. 1, 1905. No. 71786 A.

HEATING AND COOLING.

Cooling Sheds.

The New Banana Cooling Sheds at Springfield, Mo. Illustrated account of train sheds and refrigerating plant, on the American Linde refrigerating air-circulating system, for cooling trainloads of bananas in transit. 1200 w. Ice & Refrig—Sept., 1905. No. 71700 C.

Exhaust Steam.

Waste Products of a Central Station. J. A. Bendure. Abstract of paper before Ohio Electric Light Assoc., giving experiences with exhaust steam for heating. 1000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71722.

See also Mechanical Engineering, Steam.

Furnace System.

A Furnace System of Heating in a Country Store. Description and calculation of the performance of a warm air furnace heating system in a store building in Montgomery, N. Y., where for 17½ days in "zero weather," one ton of anthracite sufficed for satisfactory heating. Ills. 1800 w. Met Work—Sept. 16, 1905. No. 71909.

Refrigeration.

High-Speed Ammonia Compressor. Illustrated description of a type of machine embodying several important improvements. 700 w. Engng—Sept., 1905. No. 71782 A.

Shops.

Heating and Ventilating Railway Shops at Spencer, N. C. Describes an interesting example of a method of heating large open buildings, which involves the circulation of warmed air. Plans. 1500 w. Met Work—Sept. 16, 1905. No. 71908.

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Station Heating.

Steam Heating for Central Stations. R. S. Wallace. Discusses some of the engineering questions which require study when it is proposed to attach a steam-heating system to an existing steam power control station supplying the public with electricity for light and power. 3500 w. Technograph—No. 19, 1904-1905. No. 72263 D.

Warm Air.

Modern Methods of Heating Residences with Warm Air Furnaces and Special Side Wall Registers. E. E. Dunning. Gives illustrations and descriptions of two methods of heating with a Warm Air Furnace and the cost of installation under each plan. 2200 w. Met Work—Sept. 2, 1905. No. 71682.

Heating a Residence in Van Wert, Ohio. D. A. Clark. Illustrates and describes a warm air furnace system in which twelve rooms are supplied by six hot air pipes. 1000 w. Met Work—Sept. 23, 1905. No. 72021.

HYDRAULICS.

Pump.

Variable-Stroke Pump. Illustrates and describes an electrically-driven variable-stroke pump designed by G. W. Sinclair to meet the needs of electrical generating stations, but applicable to other purposes. 1300 w. Engng—Sept. 1, 1905. No. 71779 A.

Stream Flow.

Work of the Hydrographic Branch of the United States Geological Survey in New England and a Discussion of the Methods Used for Estimating Stream Flow. H. K. Barrows. Ills. A discussion outlining the work done, and giving a résumé of the current meter method of estimating river flow. 9000 w. Jour Assn of Engng Socs—July, 1905. No. 72258 C.

Turbine Pumps.

Modern Turbine Pumps. Otto H. Mueller. Translation from *Zeitschrift des Vereines Deutscher Ingenieure*. Discusses the operation, efficiency, design, &c., comparing types, and giving results of tests. Ills. 3000 w. Ir Age—Sept. 21, 1905. No. 71945.

MACHINE WORKS AND FOUNDRIES.

Alumino-Thermics.

See Mechanical Engineering, Miscellany.

Bevel Gears.

Bevel Gear Chart. George J. Porter. Gives formulas covering cases where the shafts are less than right angles and greater than right angles, illustrating by examples. 700 w. Mach, N Y—Sept., 1905. No. 71846 C.

Boilers.

How to Lay Out a Locomotive Boiler. Frank B. Kleinhans. An illustrated article taking up the various parts of the boiler in their turn. 3000 w. Boiler Maker—Sept., 1905. No. 71686.

Brass Furnace.

Steele-Harvey Brass Furnace Tests. William T. Krause. Gives a report of tests made with this oil furnace. Also a brief illustrated description of this melting furnace. 2000 w. Ir Age—Sept. 21, 1905. No. 71946.

Car Shops.

Equipment of the New Plank Road Car Shops of the Public Service Corporation. Martin Schreiber. Well illustrated description of special tools and general equipment of shops at Newark, N. J. 5000 w. St Ry Jour—Sept. 2, 1905. No. 71731 C.

Casting Machines.

Casting Machines and Appliances (Giesserei-Maschinen und Einrichtungen). Illustrated description. Serial. Part I. 2000 w. Stahl u Eisen—Sept. 1, 1905. No. 72170 D.

Castings.

Casting Pipe in a Rotary Mold. C. B. Stravs. Describes a process of producing pipes and hollow ingots by centrifugal force, giving results obtained. Ills. 1500 w. Ir Age—Sept. 7, 1905. No. 71875.

Hard-Skinned and Knotty Castings. Walter J. May. Discusses the things that cause an abnormally hard skin on castings, and knotty iron. 1000 w. Prac Engr—Sept. 1, 1905. No. 71671 A.

Use of Ferro-Manganese and Ferro-Silicon in the Ladle. A report of tests made and the conclusions. 900 w. Foundry—Sept., 1905. No. 72268.

Casting Wagon.

An Electrically Operated Casting Wagon. Dr. Alfred Gradenwitz. Short illustrated description of a casting wagon at the Burbach Metallurgical Works, in Lorraine. 700 w. Ir Trd Rev—Sept. 7, 1905. No. 71828.

Chain Cables.

The Manufacture of Chain Cables. L. B. Powell. Gives extract from the light-house board requirements for chain, showing what must be secured in the way of iron, and describes the forming of the selected material into chains. 3000 w. Marine Rev—Sept. 7, 1905. No. 71801.

Cores.

The Use of Covering Cores. H. J. McCaslin. Gives illustrations covering the principal uses of this class of cores, with

explanatory notes. 700 w. Foundry—Sept., 1905. No. 72269.

Crankshafts.

Machining Crankshafts for Motor Wagons. Illustrates and describes jigs and fixtures designed at an English shop for this work. 1400 w. Am Mach—Vol. 28, No. 35. No. 71862.

Cupolas.

Running Cupolas for Long Periods. Walter J. May. Suggestions for continuous working. Ills. 900 w. Prac Engr—Aug. 25, 1905. No. 71668 A.

Slagging a Cupola. David Rogers. Explains how the quantity of limestone required to form a slag in the cupola can be reduced to a system. 900 w. Foundry—Sept., 1905. No. 72271.

Cylinders.

Thick Cylinders. John S. Holliday. Gives a set of curves designed to save time and mathematical work involved in the solution of problems of Lamé's formula. 800 w. Mach, N Y—Sept., 1905. No. 71845 C.

English Methods.

The Way They Do It in England. P. W. Dillon. Relates the troubles of an American foreman in an English shop. 2000 w. Ir Trd Rev—Sept. 7, 1905. No. 71829.

Flanges.

Suggestions as to the Adaptability of a Universal Standard Flange List for Marine Work. Luther D. Lovekin. Discusses the need of a universal standard, and submits a series of flanges which have been designed with a view to overcoming all objections, explaining points in relation. 3800 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72002 H.

Lap-Joints.

Why the Lap-Joint Fails. Engravings, with notes, showing why the lap-joint is so apt to develop cracks between the sheets. 400 w. Power—Oct., 1905. No. 72245 C.

Locomotive Rods.

Forging and Repairing Locomotive Motion Rods. S. Uren. Read before the Nat. R. R. Mas. Blacksmiths' Assn. Describes methods used in the Sacramento shops to meet the changed conditions. Ills. 900 w. R R Gaz—Vol. XXXIX., No. 11. No. 71914.

Liége Exposition.

Machine Tools at the Liége Exposition (Die Weltausstellung in Lüttich 1905. Die Werkzeugmaschinen). Paul Möller. Preliminary report, with illustrations and descriptions. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1905. No. 72109 D.

Machine Operation.

Phenomena of Machine Operation. John Richards. Read before the Tech. Soc. of the Pacific Coast. Gives observed facts and typical examples, especially in regard to centrifugal pumping, turbine waterwheels, and piston steam engines. 3500 w. Am Mach—Vol. 28, No. 35. No. 71864.

Milling Machines.

Methods of a New England Milling Machine Establishment. Gives half-tones and line engravings illustrating some of the special tools and methods used at works in Massachusetts. Explanatory notes. 1800 w. Am Mach—Vol. 28, No. 39. No. 72276.

Mold Drying.

Mold Drying. Illustrates and describes several systems of drying molds. The Shedden mold-dryer, the Littleton, and the Lochner. 2200 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71678 A.

Molding.

Making the Pattern and Mold for the Side of a Power Screw Press. R. H. Palmer. Illustrated description of the methods used. 1500 w. Am Mach—Vol. 28, No. 36. No. 71868.

A New Multiple Molding Process for Relatively Deep Work. E. H. Mumford. Address before the New England Found. Assn. Illustrated description of the process developed by A. K. Beckwith. 1000 w. Met Work—Sept. 23, 1905. No. 72022.

Molding Machines.

Molding Machine Practice. F. W. Hall, in *The Patternmaker*. Remarks on recent molding machines, and their operation, with a description of the mounting of a casting. Ills. 2500 w. Foundry—Sept., 1905. No. 72273.

Selecting a Molding Machine—Molding a Cone Pulley. R. A. Bull. Suggestions for the selection of the right machine, and an illustrated description of method of making a special cone pulley. 2800 w. Am Mach—Vol. 28, No. 38. No. 71950.

Difficult Molding-Machine Work. R. Adams. Illustrates and describes a difficult case of three-parted work. 2000 w. Am Mach—Vol. 28, No. 38. No. 71951.

Up-to-Date Method of Molding. J. K. King. Discusses the introduction of molding machines into a foundry, the preparation of the machines and the points demanding attention. Ills. 2200 w. Am Mach—Vol. 28, No. 36. No. 71867.

Nut-Forming.

Nut-Tapping Machine. Illustrated description of bolt-forging, cutting and screwing machinery shown in operation

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at the St. Louis Exhibition. 1800 w. Engng—Aug. 25, 1905. Plate. No. 71772 A.

Pipe Founding.

Modern Pipe Founding. An illustrated description of the work as carried on at the Dimmick Pipe Foundry of Birmingham, Ala., and the United States Cast-Iron Pipe & Foundry Co., at Chattanooga, Tenn. 2500 w. Am Mach—Vol. 28, No. 36. No. 71865.

Pulleys.

Cone Pulley Radii. John J. Harman. Explains the method presented by Dr. L. Burmester, which is entirely graphical, and simple in application. 1200 w. Mach, N Y—Sept., 1905. No. 71843 C.

Screw Caps.

Electrically Welded Screw Caps and Bolts. Report of the Committee of the Franklin Institute, on Science and the Arts. Describes and approves the method originated by David J. Kurtz. Recommends the award of the John Scott legacy premium and medal. 1800 w. Jour Fr Inst—Sept., 1905. No. 71982 D.

Standards.

Foundry and Pattern Shop Standards. William H. Parry. Read before the A. F. A. Convention. Discussion of practices that could be improved by standardizing, with suggestions. 1400 w. Foundry—Sept., 1905. No. 72267.

Sturtevant Shops.

The New Plant of the B. F. Sturtevant Company, Hyde Park, Mass. Illustrated detailed description of the plant and its equipment. 3000 w. Ir Age—Sept. 28, 1905. No. 72275.

Thread-Miller.

Large Thread-Milling Machine. Illustrated description of a machine designed especially for cutting large worms, hobs, &c., taking work up to 12 inches diameter and 48 inches in length. 1400 w. Am Mach—Vol. 28, No. 37. No. 71869.

Tools.

Some English Tools. James Vose. Illustrates and describes a series of machine tools, designed to reproduce quickly and accurately any predetermined outline. 2200 w. Am Mach—Vol. 28, No. 36. No. 71866.

Valve Works.

Hopkinson's Valve Works at Huddersfield. Illustrated detailed description of these new works, which embrace the most commendable practice, and also their equipment. 4000 w. Engng—Sept. 8, 1905. No. 71787 A.

Welding.

See Mechanical Engineering, Miscellany.

Wheel Forging.

Car Wheel Forging. James H. Baker. Illustrates and describes improvements in forging, consisting of a peculiar distribution of the metal, of quick changing, registering and securing dies in position by power, while securing clean welded and forged metal in the tire. 1300 w. Ir Age—Sept. 7, 1905. No. 71874.

Worm Gear.

A Method of Making a Templet for Worm-Gear Tooth Patterns. John J. Smith. Illustrates and describes the method adopted in making a cast worm and gear. 3000 w. Am Mach—Vol. 28, No. 38. No. 71949.

An Oblique Worm-Drive Layout. William H. Raeburn. Diagrams and explanation of the methods employed in locating the various points and lines. 2000 w. Am Mach—Vol. 28, No. 35. No. 71861.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys. Percy Longmuir. Considers briefly the preparation of alloys, the influence of oxygen, especially in alloys containing copper as a base, and other features. Ills. 2200 w. Can Engr—Sept., 1905. Serial. 1st part. No. 72248.

Aluminium Steels and Alloys. Gives results of various investigators of these materials. 1000 w. Engng—Sept. 1, 1905. No. 71781 A.

Ferro Alloys. Auguste J. Rossi. Discusses their uses in the iron industry, especially considering titanium and its ferro combination in the electric furnace. Ills. 5000 w. Cassier's Mag—Sept., 1905. No. 72252 B.

Bronzes.

Bronzes and Brasses Used in Machine Construction and for Valves and Cocks. Ern. Roussel. Reports investigations made to determine the strength of the different bronzes and brasses used in machine construction and more particularly in locomotive building. 2000 w. 5 tables and figure. Bul Int Ry Cong—Vol. XIX., No. 6. No. 71991 G.

Cast-Iron.

Testing Cast Iron. E. L. Rhead. The present article considers principally tests of the running power of the metal, and shrinkage. 2500 w. Mech Engr—Sept. 9, 1905. Serial. 1st part. No. 71958 A.

Elbows.

The Bursting Strength of Standard Screwed Cast-Iron Elbows and Tees. S. M. Chandler. Abstract of a thesis pre-

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sented to the Case School of Applied Science. Ills. Gives results of tests and incidents of interest. 700 w. Power—Oct., 1905. No. 72247 C.

Laboratory.

The Laboratory for the Testing of Materials of the Charlottenburg Polytechnic School of Berlin. L. Ramakers. A partial description of the Gross-Lichterfelde establishment for experimental study of materials, illustrating some of the modern testing machinery and instruments installed. 2500 w. Sci Am—Sept. 9, 1905. No. 71838.

Lubricants.

New Method of Testing Lubricants. Illustrates and describes the method and machinery used by the Gebrüder Körting Electrical Co., of Berlin. 700 w. U S Cons Repts—June, 1905. No. 72020 D.

Hydrocarbon Oils and Their Value as Lubricants, with a Few Practical Tests. Frank Harris Floyd, in *The International Steam Engineer.* Explains the qualities of a good lubricant, the refining of the hydrocarbon oils, tests, &c. 2400 w. Sci Am Sup—Sept. 30, 1905. No. 72290.

Manganese.

The Effect of Manganese in Low Silicon Cast Iron. H. C. Loudenbeck. Read at A. F. A. Convention. An account of tests made to show the effect of manganese on the chill and fracture of cast iron having a low per cent. of silicon. 1000 w. Foundry—Sept., 1905. No. 72274.

Packings.

Piston-Rod Packings. R. T. Strohm. Practical discussion, with illustrations of various types. 2000 w. Am Elect'n—Sept., 1905. No. 71735.

Painting Tests.

Proper Methods in Conducting Painting Tests. Gustave W. Thompson. Abstract of paper before the American Society for Testing Materials. 3000 w. Elec Rev, N Y—Sept. 9, 1905. No. 71724.

Pig Irons.

British Pig Irons for Foundry Use. P. Munnoch. Abstract of a paper read before the Cleveland (Eng.) Inst. of Engrs. Gives typical analyses of pig irons from different districts, and variations in analyses of pig irons, discussing the effect of the various elements, mixing by analysis, &c. 2000 w. Ir Age—Sept. 7, 1905. No. 71877.

Springs.

The Strength of Laminated Springs. H. E. Wimperis. An investigation made to determine results of a degree of accuracy sufficient to yield true deflections for all practical cases of springs. 2800 w. Engr, Lond—Sept. 15, 1905. No. 72061 A.

Steel.

Properties of Steel. F. M. Thomas. Considers the properties of commercial steels, and the effects produced by various modifications in chemical composition and treatment. 5000 w. Mech Engr—Sept. 2, 1905. No. 71673 A.

Steel as an Igneous Rock. Explains Professor Arnold's views in regard to this material, based on extensive study and testing. He regards steel as an igneous rock, more or less crystalline. 2000 w. Engng—Sept. 8, 1905. No. 71788 A.

The Elastic Properties of Steel at High Temperatures. Bertram Hopkinson. Read before the Royal Society. Describes experimental investigations of the elastic properties of steel and iron, ranging up to 800 deg. Cent., and for stresses greatly below that required to rupture the material. 2200 w. Engng—Sept. 8, 1905. No. 71793 A.

Structural Materials.

The Investigation of Structural Materials by the U. S. Geological Survey. Richard L. Humphrey. An account of the arrangements for the continuance of the valuable work carried on at the Louisiana Purchase Exposition, on a much more extensive scale. 2000 w. Eng Rec—Sept. 2, 1905. No. 71891.

Tantalum.

Tantalum. Gives the physical constants of pure tantalum, discussing some of its properties and alloys. 1200 w. Engng—Sept. 1, 1905. No. 71783 A.

See also Electrical Engineering, Lighting.

Tool Steel.

High-Speed Steel in the Factory. O. M. Becker and Walter Brown. The second article of this series discusses the controlling principles in introducing the new steel tools into the factory. 4000 w. Eng Mag—Oct., 1905. No. 71707 B.

Manipulating Tool Steel, Including the High Speed Varieties. R. A. Mould. Read before the International Master Blacksmiths' Assn. Deals with the quality, treatment, etc. 2000 w. Ry Mas Mech—Sept., 1905. No. 71819.

MEASUREMENT.

Calorimeter.

The Junkers Calorimeter as an Indicator of Heating Values (Das Junkers-Kalorimeter als Heizwertanzeiger). Jos. C. Breinl. Results of comparative tests and analyses of blast furnace gas. 700 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72103 D.

Centrifugal Stresses.

Systematic Method of Computing Centrifugal Stresses. Sanford A. Moss. Gives a convenient system for the computation

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of stresses in rotating bodies due to "centrifugal force." 1800 w. Mach, N Y—Sept., 1905. No. 71842 C.

Eccentric Weights.

Forces Due to Eccentric Weights Attached to Rolling Wheels. Calvin M. Woodward. Mathematical demonstration of the action upon horizontal and curved tracks of a heavy mass attached to rigid rolling wheel. 1400 w. Jour Assn of Engng Socs—July, 1905. No. 72260 C.

Friction Losses.

Separation of the Bearing and Air Frictional Losses of Rotating Machinery by Means of the Shape of the Retardation Curve (Trennung der Lager—und Luftreibungsverluste Umlaufender Maschinenteile aus der Form der Auslaufslinie). Fritz Roehle. Graphical and mathematical analysis of curves representing the observed decreasing speeds of rotating parts acted upon by friction. 1500 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72151 B.

POWER AND TRANSMISSION.

Air Plants.

Compressed Air and Defective Installation of Air Plants. William Wilhelm. Gives facts useful to engineers in the installation of air equipment. 1300 w. Mines & Min—Sept., 1905. No. 71808 C.

Conveyors.

Conveying Machinery for Loose Material (Technische Hilfsmittel zur Beförderung und Lagerung von Samuel Körpern). Prof. M. Buhle. Illustrated description of bucket and belt conveyors and their performance. 2000 w. Stahl u Eisen—Sept. 15, 1905. No. 72171 D.

Cranes.

Forty-Ton Block-Letting Titan. Illustrated description of a "Titan" crane just completed for Table Bay harbor, which works at a radius of 115 ft. Report of tests. 600 w. Engng—Aug. 25, 1905. No. 71773 A.

Details of Electric Travelling Cranes. Illustrates and describes the arrangement and details of the electric cranes for the Wallsend Slipway Company. 1800 w. Engng—Sept. 1, 1905. No. 71785 A.

Large, High-Speed Electric Traveling Crane (Elektrisch Betriebener Laufkran Grosses Dimensionen und Hoher Geschwindig keiten). E. Egger. Illustrated description of crane driven by polyphase current, and of 80 feet span and 10 tons capacity. 1 plate. 1600 w. Zeitschr f Elektrotech—Sept. 10, 1905. No. 72165 D.

Electric Traveling Crane of 30 Tons Capacity (Pont Raulant Electrique de 30 Tonnes). Illustrated description of a crane of 79 feet span, built by the Stuckenholz Works and exhibited in the machinery building at the Liége Exposition. 1 plate. 700 w. Génie Civ—Sept. 2, 1905. No. 72140 D.

Notes on Equipment for Electric Cranes. W. H. Wakeman. Suggestions for selecting cranes for a foundry or shop. 1500 w. Elec, N Y—Aug. 30, 1905. No. 71977.

Electric Compressor.

A High-Speed Electrically Driven Compressor for Colliery Work. W. Reavell. Abstract of paper before the South Wales Institute of Engineers, giving an illustrated description of an air compressor with four cylinders disposed radially in a circular casing. 3000 w. Elect'n, Lond—Sept. 1, 1905. No. 71749 A.

Electric Driving.

Electric Driving of Textile Mills. W. B. Woodhouse. Read before the Leeds Local Soc. of the Inst. of Elec. Engrs. States the advantages of electrical driving, its applications, etc. 3500 w. Elec. Engr, Lond—Sept. 8, 1905. No. 71760 A.

The Turbo-Electric Drive in Paper Mill Service. J. R. Bibbins. An illustrated account of the experience of the West Virginia Pulp and Paper Co., Piedmont, W. Va., which is reported as successful. 3500 w. Eng Rec—Sept. 2, 1905. No. 71887.

Elevators.

The Mabbs Electric Elevator. Illustrated description of a novel and successful machine that has been in service for nearly three years. 2800 w. Engr, U S A—Sept. 1, 1905. No. 71849 C.

Hoist.

An Electrically Operated Flat Rope Hoist. Dr. Alfred Gradenwitz. Illustrated description of a hoist constructed for the Lens Mining Co., France. 1200 w. Mines & Min—Sept., 1905. No. 71807 C.

Mechanical Handling.

Loading and Unloading Apparatus for Harbors (Lösch und Ladevorrichtungen für Hafenanlagen). Bruno Müller. Illustrated description of cranes and other mechanical handling apparatus for loading and unloading ships. Serial. 1st part. 3000 w. Schiffbau—Sept. 13, 1905. No. 72122 D.

Ore Handling.

The Handling of Iron Ore. Illustrated description of the Hulett ore unloading plant. 2200 w. Engr, Lond—Sept. 8, 1905. No. 72016 A.

Power Plant.

New Power Plant of the Heyworth Building, Chicago. Illustrated description of a plant for lighting, ventilating,

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heating, refrigerating and elevator service in a modern office building of 17 stories. 3000 w. Engr, U S A—Sept. 15, 1905. No. 71941 C.

STEAM ENGINEERING.

Air-Pumps.

Watson's Independent Twin Air-Pumps. Illustrations, with description of a good example of the form of pumps usually adopted in battleships, cruisers, and mail liners, in connection with large marine engines. 800 w. Engng—Sept. 8, 1905. No. 71792 A.

Boiler Explosion.

See Railway Engineering, Motive Power.

Boilers.

Experiences with Niclausse Boilers on the U. S. S. Nevada. A. M. Cook. Gives the writer's experience with these water-tube boilers, describing the troubles and ways of overcoming them. Ills. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72003 H.

The Boiler Plant of the British Armored Cruiser "Roxburgh" (Die Kesselanlage des Englischen Kreuzers "Roxburgh"). Carl Züblin. Illustrated description of plant consisting of 17 Dürr water-tube boilers and 6 cylindrical boilers, and of trial runs. 1200 w. Schiffbau—Sept. 13, 1905. No. 72121 D.

Regulations for Care and Test of Steam Boilers. A copy of the rules recently put into effect by the Erie Railroad Co. 2200 w. Boiler Maker—Sept., 1905. No. 71687.

See also Railway Engineering, Motive Power.

Corliss Engines.

150-I.-H.-P. Corliss Engine at the Liége Exhibition. Illustrations with brief description. 400 w. Engng—Sept. 8, 1905. No. 71789 A.

Draft.

Notes on Draft. A. E. Dixon. Discusses chimneys, natural draft and the conditions affecting it, economical combustion, etc. 2000 w. Ir Age—Sept. 14, 1905. No. 71878.

Exhaust.

The Wheaton Variable Exhaust. Brief illustrated description with statement of advantages claimed. 400 w. Ry & Loc Engng—Sept., 1905. No. 71691 C.

Exhaust Steam.

The Utilization of Exhaust Steam by Means of Rateau Heat Accumulators and Low-Pressure Steam Turbines (Die Verwertung des Abdampfes durch Anwendung von Akkumulatoren und Niederdruckdampfturbinen System Rateau). Fritz Krull. Paper before the Mining and Metallurgical Congress at Liége, giving a description of system for utilizing the exhaust steam from steam engines, working intermittently, particularly winding engines. 12500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 2, 1905. No. 72177 D.

See also Mechanical Engineering, Heating and Cooling.

Feed Pump.

An Automatic Boiler Feed Pump. Henry F. Schmidt. The advantages of motor-driven or turbine-driven centrifugal pumps, with diagram. 900 w. Am Electr'n—Sept., 1905. No. 71739.

Feed-Water Heaters.

Open Feed-Water Heaters and Their Application. W. T. Edwards. Illustrated description of feed-water heaters and oil separators for power plants, particularly of the Cochrane type. 2000 w. Am Electr'n—Sept., 1905. No. 71742.

Fuel Test.

Investigation of the Heat Losses and the Heat Distribution with Incomplete Combustion (Beiträge zur Untersuchung des Wärmeverlustes und der Wärmeverteilung bei Unvollkommener Verbrennung). Paul Fuchs. Record of experiments with a fire-tube boiler and coal fuel. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1905. No. 72124 D.

Gas Fuel.

See Mining and Metallurgy, Mining.

Heat Transmission.

The Transmission of Heat from Air to Water through Corrugated Copper Tubes. Harry F. Benson. Gives formula for finding the proper amount of surface in a cooler, and mathematical solutions bearing upon this subject. 1600 w. Am Mach—Vol. 28. No. 35. No. 71863.

Oil Fuel.

The Use of Fuel Oil on the Pacific Coast. Illustrates and describes the more important features of oil handling for fuel purposes, and various applications. 1800 w. Am Mach. Vol. 28. No. 38. Serial. 1st part. No. 71948.

Oil Furnaces. John McMally. Read before the Ry. Mas. Blacksmiths' Assn. Presents some of the advantages, and the economy made possible by the low pressure system now used. Discussion. 2000 w. Ir Trd Rev—Sept. 14, 1905. No. 71906.

Packings.

See Mechanical Engineering Materials.

Portable Engine.

A New Four-Cylinder Portable Steam Engine. Translated from *La Nature*. Illustrates and describes the Lefevre motor having four cylinders which make it possible to run it as a compound engine in

two different manners, or as a triple expansion engine. It is easily applied to automobile carriages and boats. 1200 w. Sci Am Sup—Sept. 23, 1905. No. 72207.

Power-Plants.

Modern Power Plant Design and Economics. Franz Koester. The third article of this series discusses the steam turbine and the reciprocating engine and their auxiliaries, with many illustrations. 3000 w. Eng Mag—Oct., 1905. No. 71706 B.

Smoke.

The Smoke Question. F. Haier. Lecture delivered before the Hamburg and Berlin branches of the Soc. of German Engrs. Discusses the relation between smoke development and utilization of fuels, and the ways and means of smoke abatement during firing. Ills. 12800 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71996 H.

Steam Turbines.

The Steam Turbine. Prof. Storm Bull. Briefly reviews the history of steam turbine development, discussing the classification of types, the rapid introduction and the advantages over the reciprocating steam engine, giving results of tests of several kinds of turbines. Ills. Discussion. 8000 w. Jour W Soc of Engrs—Aug., 1905. No. 71990 D.

Steam Turbines as Applied to Ocean Liners. J. Harvard Biles. Abstract of a paper read before the British Assn. Briefly reviews the results of turbine steamers thus far completed, giving the writer's opinion that the turbines will completely displace the reciprocating engine in all moderate and high-speed lines. 2000 w. Elect'n, Lond—Sept. 15, 1905. No. 72085 A.

The Steam Turbine. A lecture by F. R. Low, with illustrations. Explains general principles governing steam turbines and describes the main characteristics of the several forms in use, especially with regard to their methods of using the steam. 4800 w. Power—Oct., 1905. No. 72243 C.

The Parsons Turbine (Die Parsonsturbine). F. Bauer. Paper before the "Oesterr. Vereinigung der Elektrizitätswerke," describing details and giving a comparative discussion of steam turbines. 2000 w. Zeitschr f Elektrotech—Sept. 3, 1905. No. 72164 D.

Superheating.

The Use of Superheated Steam in Engines (La Surchauffe Appliquée à la Machine à Vapeur d'Eau). François Sinigaglia. Paper before the Mechanical Congress at Liége, giving a general review of the subject, with illustrations and tables. Serial. Part I. 10000 w. Rev de Mécanique—Aug. 31, 1905. No. 72186 E + F.

The Use of Superheated Steam in Engines (Les Applications de la Vapeur Surchauffée aux Machines). Ch. Compère. Account of tests and description of apparatus. 8000 w. Mem Soc Ing Civils de France—Aug., 1905. No. 72183 G.

Superheated Steam Tests (Versuche mit Ueberhitztem Dampf). Otto Berner. Report to the Verein deutscher Ingenieure on tests conducted at the steam experimental station of the Bavarian "Revisions Verein," in Munich. 7000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72108 D.

Superheated Steam in Locomotive Service. W. F. M. Goss. Discusses the development and present state of this latest phase of locomotive engineering, giving illustrations of the most promising inventions that have been introduced. 6800 w. Jour Fr Inst—Sept., 1905. No. 71986 D.

Superheating Ten-Wheel Engine C., St. P., M. & O. Ry. A short illustrated article giving particulars of interest. 6000 w. Ry Mas Mech—Sept., 1905. No. 71820.

Test of the Machinery of the "James C. Wallace" under Superheated and Saturated Steam. W. W. White. A description and report of tests carried out on this large freighter on the Great Lakes for the purpose of securing comparative data. Ills. 2800 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72005 H.

Tube Cleaners.

The Effects of Mechanical Tube Cleaners on the Tube. William A. Parsons. A report of an investigation of the effects resulting from the use of mechanical tube cleaners, describing the methods used. Ills. 1300 w. Power—Oct., 1905. No. 72246 C.

Valve Gears.

Dr. W. F. M. Goss on Valve Gears. From a paper read before the So. & So. W. Ry. Club. Discusses the improvement of locomotive valve gear, with remarks on valve setting. 1500 w. Am Engr & R R Jour—Sept., 1905. No. 71694 C.

Valves.

Slide Valve versus Piston Valve. L. S. Allen. Read before the Traveling Engrs' Assn. A statement of the merits of the piston valve and its advantages over the slide valve. 3500 w. Ry & Engng Rev—Sept. 16, 1905. No. 71940.

Waste Heat.

Steam Boilers Worked by Waste Heat from Coal-Fired Reverberatory Furnaces. R. T. Cooke, and Percival Cooke. Illustrates and describes the proper arrange-

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ment for the economical working of the reverberatory furnace, and various types of boilers and their management. 4700 w. Cassier's Mag—Sept., 1905. No. 72256 B.

Water Softening.

Water Softening Plants. Remarks on the treatment of boiler waters, giving illustrated descriptions of a number of water softeners. 4500 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71679 A.

MISCELLANY.

Alumino-Thermics.

Goldschmidt's System of Alumino-Thermics. Report of the Committee on Science and the Arts on the invention of Dr. Hans Goldschmidt. Briefly explains the methods of thermic-welding and the applications, recommending the award of the Elliott Cresson Medal. 1200 w. Jour Fr Inst—Sept., 1905. No. 71985 D.

Welding Stern Frame of Apache. Gives details and illustrations of the welding of the break on the shoe of this steamer by the use of thermit. 1000 w. Marine Rev—Sept. 14, 1905. No. 71921.

Welding Locomotive Frames with Thermit. J. A. B. Gibson. Illustrated description of this method of welding as applied at the Boulton shops of the Richmond, Fredericksburg & Potomac R. R. 700 w. Am Engr & R R Jour—Sept., 1905. No. 71697 C.

Drafting.

Drafting Room of the B. F. Sturtevant Co. Illustrated description of the drafting-room at the new plant in Hyde Park, Mass. 2000 w. Mach, N Y—Sept., 1905. No. 71841 C.

Instructions for Draftsmen. Edwin W. Beardsley. Instructions, mostly confined to principles, intended to be applicable to the practice of the average drafting-room. 1500 w. Mach, N Y—Sept., 1905. No. 71844 C.

Liége Exposition.

The German Machinery Industry at the Liége Exposition (Lütticher Weltausstellung. Die Deutsche Maschinenindustrie). General account of engineering and mechanical exhibits with illustrations. Serial. Part I. 3000 w. Stahl u Eisen—Sept. 15, 1905. No. 72173 D.

Ordnance.

Ordnance at the Liége Exposition, 1905 (Das Waffenwesen auf der Weltausstellung in Lüttich 1905). J. Castner. Illustrated description, principally of field artillery. 3000 w. Stahl u Eisen—Sept. 1, 1905. No. 72169 D.

The Latest 12-Inch Breech-Loading Wire-Wound Guns. Drawings and description of the breech mechanism for the 12-in. Vicker's gun. 1200 w. Engr, Lond—Sept. 8, 1905. No. 72015 A.

Plumbing.

Sanitary Plumbing and the Plumbers' Craft in Relation to the Dwelling-House. A. E. Hudson. Gives examples of unsanitary conditions and discusses the main principles of modern house drainage and sanitary plumbing. 6500 w. Plumb & Dec—Sept. 1, 1905. No. 71954 A.

Difficult Joint Wiping. An illustrated article describing methods of making wiped joints in difficult positions. 2000 w. Met Work—Sept. 16, 1905. No. 71907.

MINING AND METALLURGY

COAL AND COKE.

Briquetting Plant.

Washing and Briquetting Plant. Dr. Alfred Gradenwitz. Illustrated description of the plant for screening, washing and briquetting coal at the Altstaden mine, Oberhausen, Germany. 1400 w. Mines & Min—Sept., 1905. No. 71812 C.

Charcoal.

The Manufacture and Properties of Charcoal. S. H. Stupakoff. Considers the methods in vogue for making charcoal, its uses, properties, and characteristics. 2500 w. Ir Age—Aug. 31, 1905. No. 71872.

Classification.

The Classification of Coals. Marius R. Campbell. Presents a scheme for accurately defining the various classes of coal, which applies to lignites as well as to bituminous and anthracite coals. 4000 w. Am Inst of Min Engrs—Sept., 1905. No. 72298 C.

Coal Plant.

The Iselin Plant. F. L. Dixon. An illustrated description of the principal features of the model new coal plant at Iselin, Indiana County, Pa. 1800 w. Mines & Min—Sept., 1905. No. 71802 C.

Coke Manufacture.

The By-Product Coke Oven. W. H. Blauvelt. Explains the differences in structure and method of operation between the old beehive oven and the retort oven, arranged for the saving of the by-products, illustrating the most prominent systems of the latter. Gives a descrip-

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tion of the operation of by-product coke ovens, and other information. Discussion. Ills. 9000 w. Jour W Soc of Engrs—Aug., 1905. No. 71987 D.

Coking Process for Poorly Coking Coal (Verkokungsverfahren für Schlechtbackende Kohle). Oskar Simmersbach. Illustrated description of the Schwarz process. 800 w. Stahl u Eisen—Sept. 15, 1905. No. 72172 D.

Colorado.

Coal Fields of Routt County, Colo. Describes one of the best coal fields of the Rocky Mountain region. 1500 w. Min Wld—Sept. 9, 1905. No. 71817.

Electric Power.

Earth in Collieries, with Reference to the "Special Rules for the Installation and Use of Electricity." Sydney F. Walker. Read before the Inst. of Min. Engrs. An explanation of the term and of the conditions usually found in mines as affecting electrical installations, and their designers. 3500 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72074 A.

Explosions.

Can Explosions in Coal Mines, with Their Associated Toxic Fatalities, Be Prevented? B. H. Thwaite. Read before the Inst. of Min. Engrs. Presents the arguments showing that a removal of the coal dust would greatly lessen the danger, and describes an apparatus for effecting its removal. 3500 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72073 A.

Cambrian Collieries Explosion. A report of the circumstances attending the explosion which occurred on March 10, 1905. 4000 w. Col Guard—Sept. 1, 1905. No. 71676 A.

Rush Run Mine Explosions. W. F. Paul. An account of the two explosions at Rush Run and Red Ash mines, West Virginia, March 18 and 19, 1905. 4000 w. Mines & Min—Sept., 1905. No. 71810 C.

Great Britain.

The Search for Coal Beneath the Red Rocks of the Midland Counties. Wolcot Gibson. From the summary of progress of the Geological Survey for 1904. Gives the more important results obtained from the examination of several borings. 3800 w. Ir & Coal Trds Rev—Sept. 8, 1905. No. 71967 A.

Indian Territory.

The Poteau Coal Mines. Prof. W. R. Crane. An illustrated description of the modern equipment and methods of working employed. 3500 w. Mines & Min—Sept., 1905. No. 71811 C.

Lancashire.

Leading Features of the Lancashire Coal Field Extended. Joseph Dickinson. Read before the Inst. of Min. Engrs. Outlines briefly information given in an earlier paper, and describes additional features, bringing the account up to date. 4000 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72071 A.

Longwall Workings.

The Action, Influence and Control of the Roof in Longwall Workings. H. G. Halbaum. (Prize essay.) Gives conclusions drawn from experience and from mechanical and geological theory. 5200 w. Ills. Mines & Min—Sept., 1905. Serial. 1st part. No. 71806 C.

Peat.

The Utilization of Peat. Editorial review of processes tried and proposed for drying peat and preparing it for use on a commercial scale. 2300 w. Engng—Aug. 25, 1905. No. 71776 A.

Peat and Its Relation to Coal. A. Lakes. Explains what peat is, its natural history, where and under what conditions it is found, its chemical and fuel composition, and how it can best be utilized. Ills. 1000 w. Min Rept—Aug. 31, 1905. No. 71822.

Sampling.

The Commercial Value of Coal-Mine Sampling. Marius R. Campbell. Describes the method of sampling for the geological survey coal-testing plant at St. Louis, and gives a proposed method for general work. 3500 w. Am Inst of Min Engrs—Sept., 1905. No. 72299.

Truesdale Plant.

The Truesdale Plant. Begins an illustrated description of one of the most complete anthracite collieries, having the largest breaker in the field, which is electrically operated. 800 w. Eng & Min Jour—Sept. 2, 1905. Serial. 1st part. No. 71928.

COPPER.

Analysis.

Wholesale Copper Analysis. A. H. Jackson. Abstract of a paper read before the Incor. Inst. of Analysts, Assayers & Metallurgists, at Melbourne. A record of the electrolytic method used by Mr. Rhodin, for testing Muntz metal. Ills. 350 w. Aust Min Stand—Aug. 16, 1905. No. 71964 B.

Copper Sheets.

A New Process for the Manufacture of Copper Sheets, Tubes and Wire. Sherard Cowper-Coles. Revised paper, recently read before the Faraday Society. Illustrates and describes the various processes used to increase the current density by using mechanical means for keeping the copper from getting rough. 1500 w. Prac Engr—Aug. 25, 1905. Serial. 1st part. No. 71669 A.

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South Africa.

Notes on Copper Deposits Near Tokar, Sudan. W. H. Shockley. Illustrations, with brief account of these deposits. 600 w. Min & Sci Pr—Sept. 9, 1905. No. 71927.

United States.

Copper Metallurgy in the United States (La Métallurgie du Cuivre aux Etats-Unis). F. Glaizot. General account of copper production and metallurgy, with illustrations and curves. 13000 w. Mem Soc Ing Civils de France—July, 1905. No. 72181 G.

GOLD AND SILVER.

Australia.

Australia's New Silver Field. John Plummer. Information concerning the recent discoveries of a silver-lead field at Coppabella, in New South Wales. 800 w. Min Wld—Sept. 23, 1905. No. 72239.

Mount Boppy Goldfield (N. S. W.). J. B. Jaquet. Report to the N. S. W. Dept. of Mines. Information concerning this mine and its development. 1500 w. Min Jour—Aug. 26, 1905. No. 71674 A.

Concentration.

Concentrating Pavilion of the United States Geological Survey, at Lewis and Clark Exposition. Waldon Fawcett. Brief illustrated description of a structure for experimental work in saving platinum from black sand. 1000 w. Mines & Min—Sept., 1905. No. 71803 C.

Cripple Creek.

The Future of the Cripple Creek District. G. E. Wolcott. Discusses the general conditions of the ore deposits and their bearings on the high cost of mining, the methods employed in mining and treating, and the future development. 2000 w. Min Rept—Aug. 31, 1905. No. 71823.

Fraser River.

The Source of the Fraser River Gold. Horace F. Evans. Discusses briefly the probable source of the gold found in the Fraser River placers. 2000 w. Min Wld—Sept. 2, 1905. No. 71813.

Hydraulic Mining.

Hydraulic Mining on Banner Placer, Colorado. Kirby Thomas. Describes arrangements made to secure a sufficient supply of water for hydraulic mining, and the methods of working. Ills. 1700 w. Min Wld—Sept. 16, 1905. No. 71924.

Mexico.

Guanajuato. James W. Malcolmson. Information concerning methods past and present; in this field more silver is said to have been mined than in any other district in the world. Gold is also found. 1200 w. Eng & Min Jour—Sept. 23, 1905. No. 72210.

Nevada.

Genetic Relations of the Western Nevada Ores. J. E. Spurr. Discusses especially the ore-deposit at Tonopah, and Silver Peak, comparing them with other regions, and giving conclusions regarding their origin. 10600 w. Am Inst of Min Engrs—Sept., 1905. No. 72305 D.

Placers.

What Constitutes a Placer. Arthur Lakes. Describes how placer deposits are formed, and the causes of barrenness of one gulch and the richness of another. 1500 w. Min Wld—Sept. 23, 1905. No. 72238.

River Channels.

Ancient Gravel Channels of Calaveras County, California. From the 12th Annual Report of the State Mineralogist of California. Map, with outline of the processes by which these ancient gold-bearing channels were formed is given in the present number. 1700 w. Min & Sci Pr—Sept. 9, 1905. Serial. 1st part. No. 71926.

Siberia.

Siberian Gold Mining. George E. Walsh. Gives the location and extent of some of the gold fields discovered, and some of the conditions which retard development. 2000 w. Mines & Min—Sept., 1905. No. 71809 C.

Sulphides.

The Newer Treatment of Broken Hill Sulphides. A. Selwyn-Brown. Describes several processes now successfully employed in the treatment of the immense bodies of tailing, culled zinc ores that have accumulated, awaiting the researches of metallurgists. 1200 w. Eng & Min Jour—Sept. 2, 1905. No. 71879.

Tropical Mining.

Mining in Tropical Regions. Abstract from *L'Industrie Aurifere*. Describes methods of placer exploitation in French Guiana. 1500 w. Min Wld—Sept. 9, 1905. No. 71818.

Veins.

The Magmatic Origin of Vein-Forming Waters in Southeastern Alaska. Arthur C. Spencer. A study of the source of the vein-forming waters of this region, describing the geology. 2800 w. Am Inst of Min Engrs—Sept., 1905. No. 72294.

Witwatersrand.

Present Stage of Metallurgy on the Witwatersrand. G. A. and H. S. Denny. Gives an outline of present practice, and alterative suggestions made by the writers, with reasons and causes. 7000 w. Min Mag—Sept., 1905. No. 72034 C.

The Witwatersrand Deep Electrical Plant. Illustrates and describes the elec-

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trical plant of the Witwatersrand Deep Gold Mining Co., Ltd., which is of the most modern type. 1500 w. Elec Engr, Lond—Aug. 25, 1905. No. 71755 A.

IRON AND STEEL.

Blast Furnaces.

Notes on the Physical Action of the Blast Furnace. J. E. Johnson, Jr. Discusses some of the physical and mechanical aspects of the blast-furnace process, pointing out its dependence in these respects on well-known laws. 12500 w. Am Inst of Min Engrs—Sept., 1905. No. 72304 D.

Blast-Furnace Calculations. J. L. Stevenson. Gives the methods by which to arrive at the shape and size of furnace and the necessary equipment for the production of the output decided upon. Ills. 2800 w. Engr, Lond—Aug. 25, 1905. No. 71794 A.

Effect of the Oxides of Carbon Upon Iron and Its Oxides. A review of investigations of the destruction of blast-furnace linings, giving results obtained from various sources. 2500 w. Engng—Sept. 15, 1905. Serial. 1st part. No. 72068 A.

The Use of High Percentages of Fine Ore in a Charcoal Blast-Furnace. Harry R. Hall. An account of successful work under adverse conditions. 1500 w. Am Inst of Min Engrs—Sept., 1905. No. 72303.

Blowholes.

Processes for Preventing the Formation of Blowholes in Steel Ingots (Die Verfahren zur Verhütung der Lunkerbildung in Stahlblöcken). R. M. Daelen. Paper for the International Mining Congress at Liége, giving illustrated descriptions. 800 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72102 D.

Preventing the Formation of Cavities in Steel Ingots. F. O. Beikirch in *Stahl und Eisen.* Describes a method based on the formation of a waste head. Ills. 1200 w. Ir & Coal Trds Rev—Aug. 25, 1905. No. 71677 A.

Cementation.

The Brittleness of Case-Hardened Soft Steel (Sur la Fragilité des Aciers Doux Cémentés). J. Lecarme. Account of researches to determine the real cause of the brittleness of steel due to the cementation process of surface hardening, with micrographs, and note by H. Le Chatelier. 3000 w. Rev de Métallurgie—July, 1905. No. 72189 G.

Chrome Steel.

Chrome Steel as a Commercial Product (Comment l'Acier Chromé est Devenu un Produit Industriel). A. Brustlein. Brief review of the history and applications of chrome steel. 3000 w. Rev de Métallurgie—July, 1905. No. 72188 G.

Magnetic Separator.

The Snyder Magnetic Separator. Frederick T. Snyder. Illustrated detailed description of a magnetic separator and its operation. 1000 w. Eng & Min Jour—Sept. 2, 1905. No. 71881.

Metallography.

The Technique of Microscopic Metallography (Sur la Technique de la Metallographie Microscopique). H. Le Chatelier. Practical directions for methods of research. 4000 w. Rev de Métallurgie—July, 1905. No. 72190 G.

Nitrogen Influence.

The Influence of Nitrogen on Iron and Steel (Influence de l'Azote sur le Fer et l'Acier). Hjalmar Braune. Showing that combined nitrogen, taken up in the course of manufacture, is the cause of brittleness in iron and steel, with micrographs and a note by H. Le Chatelier. 2500 w. Rev de Métallurgie—July, 1905. No. 72187 G.

Nodulating.

A Process for Converting Fine Iron Ores into Nodules. Illustrates and describes the plant and process. 2000 w. Ir Age—Sept. 7, 1905. No. 71873.

Nova Scotia.

The Iron Ores of Nova Scotia. Abstract from summary report of Geological Survey of Canada (Ottawa, 1905). Gives information concerning the iron ores of Nictaux and Torbrook, Annapolis Co., N. S. 3500 w. Can Min Rev—Sept., 1905. No. 71847 B.

Open Hearth.

Open Hearth Molten Metal Processes. Oskar Simmersbach, in *Stahl und Eisen.* Describes and compares the various methods which have been worked to use molten iron in open hearth practice. 5000 w. Ir Age—Sept. 7, 1905. No. 71876.

Open Hearth Furnace Comparisons. A. D. Williams, Jr. Gives a table showing hearth dimensions for 18 furnaces and the ratio between hearth area and capacity and the length and width, discussing matters related. 1700 w. Ir Age—Sept. 21, 1905. No. 71947.

Pyrites.

Pyrites Mining and Milling in Virginia. Robert K. Painter. Gives some average costs, discussing value of deposits, size of concentrate, dressing, &c. 1000 w. Eng & Min Jour—Sept. 9, 1905. No. 71883.

Roasting.

Kernel-Roasting. Herman Poole. Describes the various stages of roasting of pyrites, and the explanations of the causes of the action as given by various

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writers. Ills. 3200 w. Am Inst of Min Engrs—Sept., 1905. No. 72300.

Rolling Mills.

Electrically-Driven Rolling Mills. Ralph W. Birkett. A short account of, and deductions drawn from the writer's observations of the working of an electrically-driven mill recently erected at Queensferry. 4500 w. Engr, Lond—Sept. 8, 1905. No. 72014 A.

New Universal Rolling Mills (Neuere Universalwalzwerke). Fr. Fröhlich. Illustrated description of rolling mills at the National Tube Co.'s, Pittsburg, and at some Continental works. 1000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72107 D.

An Armor Plate Rolling Mill. Illustrated description of a rolling mill, recently constructed to the order of the French Navy Department, and its operation. 500 w. Engr, Lond—Sept. 1, 1905. No. 72008 A.

Steel-Making.

The Bessemer v. the Open Hearth System. John Parry. A comparison, discussing the advantages and disadvantages of the two systems. 2000 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71680 A.

Steel Sections.

The German Book of Standard Steel Sections for Structural and Shipbuilding Work (Deutsches Normalprofilbuch für Walzeisen zu Bau- und Schiffbau-Zwecken). Extracts from memoir by Prof. Heinzerling, giving a history of the committee of the Verein deutscher Ingenieure, on standard sections, and a report of the present committee, by F. Kinzlé and E. Schroedter, with diagrams and tables. 10000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1905. No. 72110 D.

New I-Beam Sections in the German Standard-Section Book of Rolled Shapes? (Neue Doppel-T-Reihe im Deutschen Normalprofilbuch für Walzeisen?). Discussion of new sections proposed by committee of the Verein Deutscher Ingenieure. 3 Plates. 6000 w. Stahl u Eisen —Sept. 1, 1905. No. 72168 D.

Wrought-Iron.

The Manufacture and Characteristics of Wrought-Iron. A discussion of the paper by James P. Roe, read at the Washington meeting, May, 1905. 7000 w. Am Inst of Min Engrs—Sept., 1905. No. 72296 C.

The Manufacture and Characteristics of Wrought-Iron. Taylor Allderdice. A communicated discussion of the paper by James P. Roe, read at the May meeting. 1200 w. Am Inst of Min Engrs—Sept., 1905. No. 72302.

MINING.

Australia.

Ventilation and Sanitation of Mines in Western Australia. Extracts from report of Royal Commission. Considers dust in mines and mills, gases due to explosives, fumes from the cyanide process, etc. 3500 w. Min Rep—Sept. 14, 1905. No. 71922.

Blasting.

Blasting Coal in Bituminous Mines. J. T. Beard. States the conditions that have led to the excessive use of powder, and discusses the placing of shot, the location of the charge, the direction and depth of the hole, and the manner of firing. Ills. 3000 w. Eng & Min Jour—Sept. 23, 1905. Serial. 1st part. No. 72211.

Debris.

Control of Hydraulic Mining Debris in California by the Federal Government. Abstract of a lecture by Capt. Wm. W. Harts, at San Francisco, Cal., giving an account of what has been done and what is proposed in this great work. Ills. 4000 w. Min & Sci Pr—Sept. 2, 1905. No. 71830.

Electric Equipment.

New Electric Equipment for Two Belgian Coal Mines (Zwei Neue Bergwerksanlagen mit Elektrischem Antrieb in Belgien). Adolf Spier. Description of electric plants and machinery at coal mines near Mons and Liége, with diagrams of the hoisting operations. 7000 w. Glückauf—Sept. 2, 1905. No. 72175 D.

Up-to-Date Electrical Power Distribution. R. Loraine Gamlen. Read before the Inst. of Min. Engrs. Discusses the things necessary for success if a Power Company is to supply the power for mines. 4000 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72072 A.

Uses of Electricity in Mines. Henry Willock Ravenshaw. Describes the various applications of electricity in general use in mines, giving facts from actual practice. Ills. 4000 w. Jour Soc of Arts—Sept. 1, 1905. Serial. 1st part. No. 71662 A.

Electrical Mining Notes. Sydney F. Walker. Discussion of machinery, locomotives, ignition of coal dust and of gas, earth and leakage and other topics. 2000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71720.

Explosives.

Continental Explosives Testing Stations. Information from a report to the Home Secretary, on visits to certain explosive factories and testing stations in Belgium, Germany and Holland, the methods of testing and results. 4500 w. Col Guard—Aug. 25, 1905. No. 71675 A.

We supply copies of these articles. See page 319.

Jig.

A Hand Jig. William S. Thyng. Brief illustrated description of a hand jig which was used to good advantage in concentrating crude tungsten ore for the market. 700 w. Eng & Min Jour—Sept. 16, 1905. No. 71933.

Lead Mining.

Lead Mining in the Linares District, Spain. Norman Carmichael. An illustrated article describing the conditions obtained at Linares, one of the important producing districts of Spain. 5000 w. B C Min Rec—Aug., 1905. No. 71821 B.

Lead Mining in Southeastern Missouri. R. D. O. Johnson. Describes the deposits and methods of mining. 2300 w. Eng & Min Jour—Sept. 16, 1905. No. 71929.

Mine Gas.

An Interesting Utilization of Mine Gas (Ueber einen Interessanten Fall von Grubengasverwertung). Karl Fric. Gas from a coal mine at Dombrau, Austria, is used for fuel under a steam boiler. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 9, 1905. No. 72178 D.

Mine-Maps.

Geological Mine-Maps and Sections. D. W. Brunton. Recommends a more extended use of mine-maps, explaining method and giving drawings, showing how valuable they may be made. 1800 w. Am Inst & Min Engrs—Sept., 1905. No. 72297.

Mine Ventilation.

Progress in Ventilation of Victorian Gold Mines. F. D. Johnson. Describes the condition of these mines in the past and present, and some of the difficulties in bringing about better conditions. 2200 w. Min Jour—Sept. 16, 1905. No. 72066 A.

The Vitiation of the Air in Transvaal Mines. James Moir. Discusses (1) Air from Compressors, (2) Ordinary Working Mine Air, and (3) Gases after Blasting with Nitro-glycerine Explosives. 5000 w. Jour of Chem, Met & Min Soc of S Africa—July, 1905. No. 71961 E.

Roasting.

The Theory and Practice of Roasting. A. W. Warwick. A discussion of the scientific principles of roasting, based on practical experience and a large number of pyrometric observations and analyses. Ills. 4000 w. Min Mag—Sept., 1905. No. 72036 C.

Sampler.

An Emergency Sampler. W. Denham Verschoyle. Illustrates and describes an inexpensive sampling device and reports the tests made of it. 500 w. Eng & Min Jour—Sept. 16, 1905. No. 71930.

Winding Ropes.

Accidental Breakage of Winding Ropes in Mines. Prof. John Perry. Read before the British Assn. at Johannesburg. Gives several problems and the writer's method of solving them. Mathematical. 3000 w. Engr, Lond—Sept. 1, 1905. No. 72012 A.

MISCELLANY.

Asbestos.

Asbestos. E. B. Wilson. An illustrated article describing different varieties and their characteristics; the methods of milling and preparing the amphibole asbestos. 1000 w. Mines & Min—Sept., 1905. No. 71805 C.

Asphalt.

Asphalt in the Indian Territory. W. R. Crane. Describes the deposits giving information concerning the cost of production, development, etc. 1500 w. Eng & Min Jour—Sept. 9, 1905. No. 71884.

Assaying.

Assaying Tin and Tin-Lead Compounds. P. J. Thibault. Gives results of experimental investigations of the dry determination of silver. 1800 w. Aust Min Stand—Aug. 9, 1905. No. 71963 C.

Diamonds.

Diamonds. Sir Wm. Crookes. Abstract of lecture before British Assoc. describing the making of artificial diamonds. experiments on diamonds, etc. 4000 w. Elect'n, Lond—Sept. 8, 1905. No. 71752 A.

The Genesis and Physical Properties of Diamonds. Sir William Crookes. Abstract of a paper read before the Assn. Describes the mines of South Africa and the deposits, and discusses the theory of formation and origin. 3000 w. Min Jour—Sept. 9, 1905. Serial. 1st part. No. 71965 A.

First Aid.

First Aid to the Injured in Mines. M. J. Shields. The present article is introductory, explaining the growth of the movement of rendering first aid, and giving an account of the work as established in mines. 2200 w. Eng & Min Jour—Sept. 16, 1905. Serial. 1st part. No. 71934.

Flints.

Flints and Other Hard Rocks as Material for Tube Mills. Prof. Arthur Lakes. Explains the origin of flint and other hard rocks, used in tube mills for grinding ores. 1200 w. Mines & Min—Sept., 1905. No. 71804 C.

Furnace.

A Furnace for Metallurgical Research. Woolsey McA. Johnson. Describes a furnace designed for use in a metallurgical laboratory; the fuel used was nat-

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ural gas. Ills. 1500 w. Elec-Chem & Met Ind—Sept., 1905. No. 72094 C.

Lead Smelting.

The Huntington-Heberlein Process at Friedrichshütte. A. Biernbaum. Translated from *Zeitschrift für das Berg-Hütten- und Salinenwesen.* An account of the introduction of this process at Tarnowitz, Prussia, where it has completely displaced the old processes of local smelting. 4000 w. Eng & Min Jour—Sept. 23, 1905. No. 72212.

The New Methods of Desulphurizing Galena. W. Borchers. Translation from *Metallurgie.* Also editorial. Discusess critically the reactions involved in the new methods given in the processes of Huntington-Heberlein, Savelsberg, and Carmichael-Bradford. 4200 w. Eng & Min Jour—Sept. 2, 1905. No. 71882.

The Lead Smelting Plant at Monteponi, Sardinia (Die Bleihütte zu Monteponi). E. Ferraris. Illustrated description of furnaces and other parts of plant, and operating results. 1 plate. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 2, 1905. No. 72176 D.

Lead Smelting Works at Monteponi, Sardinia. Erminio Ferraris. An illustrated article describing the works, their equipment and operation. 1400 w. Min Mag—Sept., 1904. No. 72035 C.

Mica.

Mica and the Mica Industry. George Wetmore Colles. The treatment is industrial rather than scientific or theoretical, and aims at setting forth the present, past, and probable future of mica-mining in this and other countries. 5000 w. Jour Fr Inst—Sept., 1905. Serial. 1st part. No. 71984 D.

Petroleum.

The Latest American Petroleum Discoveries. Day Allen Willey. An illustrated article describing the great expansion of the oil industry in the United States, west of the Mississippi River, and in the Southwest, and the uses made of the liquid fuel. 4000 w. Cassier's Mag—Sept., 1905. No. 72253 B.

Phosphates.

Sources of Supply and Methods of Manufacture of Phosphates and Potash Salts. Edward B. Voorhees. A brief account of the various sources of supply of natural phosphates especially in the United States. Also an account of the Stassfurt deposits of potash salts. 1800 w. Jour Fr Inst—Sept. 1905. No. 71985 D.

Platinum.

Test for Platinum (Die Platinprobe). Dr. Nordenskjöld. Reprint from *Tekinsk Tidskrift,* giving chemical processes for determining platinum, iridium, etc. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 9, 1905. No. 72179 D.

Quicksilver.

Terlingua Quicksilver District. William B. Phillips. Notes on the quicksilver industry in this district of Texas, describing the manner in which the cinnabar occurs in the upper cretaceous. 1200 w. Min Wld—Sept. 2, 1905. No. 71814.

South Africa.

South Africa Mining Progress. Ralph Stokes. Discusses the progress since the close of the war, explaining conditions in the gold fields, and the rise of the diamond industry. Brief notes are also given on other minerals found. 2800 w. Min Wld—Sept. 16, 1905. No. 71925.

Tin.

Alluvial and Lode Tin in Malaya. J. B. Scrivener. From the annual report of the Federated Malay States. Describes three mines of detrital tin associated with limestone, gives information of tin lodes, and briefly discusses the origin of the deposits. 2400 w. Min Jour—Sept. 9, 1905. No. 71966 A.

Tin Refining.

See Electrical Engineering, Electro-Chemistry.

Tonkin.

The Mineral Resources of Tonkin. Henry Charpentier. Information concerning the deposits of coal, iron ore, copper, tin, and manganese ores. 1800 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71681 A.

Wolfram.

Wolfram in Queensland. B. Dunstan. From the Annual Progress Report, Geological Survey of Queensland, for 1904. Information concerning the localities, deposits, developments, etc. 2300 w. Queens Gov Min Jour—July 15, 1905. No. 71667 B.

Zinc.

The Silesian Zinc Industry. George P. Scholl. A report of the zinc industry in this district, its output, ore deposits, smelting, and other information. 4000 w. Min Mag—Sept., 1905. No. 72037 C.

The Quapaw Zinc District. W. R. Crane. Describes the deposits in this Indian Territory district, and the methods of mining and milling. Ills. 2300 w. Eng & Min Jour—Sept. 16, 1905. No. 71932.

Zinc Oven.

Cylinder Ovens for Zinc Production (Zylinderofen für Zinkerzeugung). Friedrich Kellermann. Illustrated description of vertical oven for poor, but easily smelted zinc ores. 1000 w. Glückauf—Aug. 26, 1905. No. 72174 D.

We supply copies of these articles. See page 319.

CONDUCTING TRANSPORTATION.

Train Breaking.

Breaking in Two of Long Trains, Passenger and Freight, at Slow Speeds, When Releasing Brakes, and Methods of Prevention. Read before the Traveling Engrs' Assn. Considers the forces which the draw bars and couplers have to withstand and some of the causes of break-in-twos. 3000 w. Ry & Engng Rev—Sept. 23, 1905. No. 72241.

MOTIVE POWER AND EQUIPMENT.

"Alton Limited."

The New "Alton Limited." Illustrated description of fine passenger equipment for this train. 1000 w. R R Gaz—Vol. XXXXIX., No. 9. No. 71853.

Boiler.

The Brotan Locomotive Boiler. H. W. Hanbury. Illustrated description of a novel water-tube locomotive boiler shown at the Liége exhibition, discussing its advantages and disadvantages. 2200 w. Engng—Sept. 1, 1905. No. 71780 A.

Car Framing.

End Shocks in Car Service and Provision for Same in Car Framing. A. Stucki. Discusses present service conditions, present car equipments, advantages of a standard to regulate both, and the best basis for such a standard. Ills. 2500 w. Pro Ry Club of Pittsburg—Sept. 29, 1905. No. 72099 C.

Cars.

75-Ton Steel Flat Car. Illustrated detailed description of cars built for the Pittsburgh & Lake Erie R. R. 700 w. Am Engr & R R Jour—Sept., 1905. No. 71695 C.

Drawbars.

Experiments on the Behavior of Elastic Drawbars, on the von Borries and Wick Systems. Mr. Fischer. Describes experimental investigations made by the Royal Berlin Railway Management, stating their object, describing trials, and giving results. 9000 w. 9 tables and figs. Bul Int Ry Cong—Vol. XIX., No. 6. No. 71992 G.

Some Remarks on the Drawbar Trials Carried Out by the Royal Berlin Management. J. Doyen. Remarks on the conclusions reached, drawing attention to weak points in the Berlin trials. 1600 w. Bul Int Ry Cong—Vol. XIX., No. 6. No. 71993 G.

Dynamometer Car.

The New Pennsylvania Dynamometer Car. W. O. Dunbar. Description given in a discussion before the Engineers' Club of Philadelphia. 2500 w. Am Engr & R R Jour—Sept., 1905. No. 71696 C.

Headlight.

Electric Headlight for Locomotives. Illustrated description of the Edwards electric headlight, which is in use in America, India, and South Africa. 600 w. Engr, Lond—Aug. 25, 1905. No. 71797 A.

India Train.

Royal Train for India. Illustrated description of the new train constructed by native labor, under European supervision, from raw material, for the use of the Prince and Princess of Wales on their Indian tour. 1200 w. Engng—Sept. 15, 1905. Serial. 1st part. No. 72067 A.

Locomotive Design.

Some Factors in British Locomotive Design. Charles S. Lake. An illustrated article considering improvements in power capacity of locomotives intended for maximum service on main lines of railway. 1200 w. Mech Engr—Aug. 26, 1905. Serial. 1st part. No. 71672 A.

Locomotive Explosion.

Explosion of a Locomotive Boiler at the St. Lazare Station, Paris (Explosion d'une Chaudière de Locomotive aux Abords de la Gare Saint-Lazare). Robert Dubois. Fully illustrated account of explosion and investigation into its causes. 6000 w. Bull d l Soc d'Encouragement—July 31, 1905. No. 72180 G.

Locomotives.

Combined Rack and Adhesion Locomotive for South Africa. Illustration and description of a powerful engine for assisting the heavy express trains over exceptionally severe gradients. 800 w. Sci Am—Sept. 30, 1905. No. 72289.

Consolidation 2-8-0 for the Colorado-Utah Construction Company. Illustrates and describes engines of great strength, recently completed. An interesting feature is the adjustable hood on the smoke stack. 400 w. Ry & Loc Engng—Sept., 1905. No. 71693 C.

Express Locomotives. A. A. H. Tokeley. Discusses the design of high-speed locomotives. 2800 w. Engr, Lond—Sept. 15, 1905. No. 72060 A.

Lehigh Valley Ten-Wheel Locomotive. Illustrates and describes engines principally remarkable for their great weight.

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The total weight in working order is 199,200 pounds. The heating surface also is large. 250 w. Ry Age—Sept. 22, 1905. No. 72200.

New Bogie Tank Engines, Southeastern and Chatham Railway. Dimensions and illustrated particulars of engines designed for heavy suburban trains. They are fitted with spark arresters and fuel economizers. 700 w. Engr, Lond—Aug. 25, 1905. No. 71795 A.

New Locomotives for the Indian State Railroads. Illustrates and describes a bogie express engine, and a freight engine designed for Indian climatic conditions. 600 w. R R Gaz—Vol. XXXIX., No. 11. No. 71917.

New Locomotives—Natal Government Railways. Illustrated description of engines specially designed to work the mail traffic in the main line between Durban and Charlestown. 400 w. Engr, Lond—Sept. 15, 1905. No. 72064 A.

New Type of Bavarian Four-Cylinder Compound Locomotives. Charles R. King. Also editorial. Illustrated description of powerful new engines recently designed for hauling heavy trains, with explanatory notes and comments. 4000 w. Ry Age—Sept. 15, 1905. No. 71938.

Tandem Compound Freight Locomotive, N. P. Ry. Illustrated description of very heavy freight locomotives of the 2-8-2 type. 800 w. Ry & Engng Rev—Sept. 16, 1905. No. 71939.

Tank Locomotive for Egyptian Delta Light Railways. Dimensions and illustrations of a six-wheel coupled bogie tank engine, 2 ft. 5½ in. gauge. 300 w. Engng—Sept. 8, 1905. No. 71790 A.

Motor Cars.

Rail Motor Cars in Great Britain. F. Gairns. The present article states the advantages of these vehicles, gives a general classification, and illustrated descriptions of examples of steam cars. 4800 w. Cassier's Mag—Sept., 1905. Serial. 1st part. No. 72254 B.

Motor Railway Coach. Illustrated description of the steam rail motor coach introduced by the London and Northwestern Railway. 600 w. Engr, Lond—Sept. 15, 1905. No. 72063 A.

Railway Motor Coach. Illustrated description of the interesting engine used in the motor passenger carriage introduced on the Great North of Scotland Railway. 500 w. Engr, Lond—Sept. 1, 1905. No. 72011 A.

Steam Coach.

Stean Coach; Great North of Scotland Railway. Illustrations of coach and boiler with short description. 350 w. Engng—Aug. 25, 1905. No. 71774 A.

Superheating.

See Mechanical Engineering, Steam.

NEW PROJECTS.

Cape-to-Cairo.

Recent Progress on the Cape-to-Cairo Railway. J. Hartley Knight. Well illustrated account of the present state of the main line and branches to the coast, with map. 4000 w. Eng Mag—Oct., 1905. No. 71702 B.

China.

Railway Construction in North China, E. H. Rigby and W. O. Leitch, Jr. Extract from a paper read before the Inst. of Civ. Engrs. Principally a description of the Chinchou-Yingkow Section, with map. 4000 w. R R Gaz—Vol XXXIX. No. 11. No. 71916.

Florida Keys.

Steamboat Travels Over Proposed Site for Railroad to Key West. Russell B. Smith, in the *N. Y. Herald*. An account of a trip which gives some idea of this great undertaking. 1000 w. Naut Gaz—Aug. 31, 1905. No. 71699.

Sierra Leone.

Sierra Leone Government Railway. History and illustrated description of this narrow gauge railway, and its rolling stock. 2500 w. Engr, Lond—Aug. 25, 1905. No. 71799 A.

Western Pacific.

Plans of the Western Pacific. An account from the annual report of the Denver & Rio Grande, of the financial and other plans embodied in the creation of the line from Salt Lake City to San Francisco. 1600 w. Ry Age—Sept. 15, 1905. No. 71935.

PERMANENT WAY AND BUILDINGS.

Coal Piers.

New Lackawanna Coal Piers. Illustrated description of recently completed piers at Hoboken, N. J., which possess features of novelty and interest. 1800 w. Ry Age—Sept. 15, 1905. No. 71936.

Freight-Terminals.

The Chicago Freight Terminals of the Chicago & Northwestern. Gives maps and plans with description and information of the methods of handling the freight. 4500 w. R R Gaz—Vol. XXXIX. No. 11. Serial. 1st part. No. 71915.

Grade-Crossings.

Grade-Crossing Problems in St. Louis. Carl Gayler. Gives a short review of the history of railroading in St. Louis, and some of the cases of grade-crossings and their treatment. General discussion. Ills. 7000 w. Jour Assn of Engng Socs—July, 1905. No. 72259 C.

Grand Central Station.

The Grand Central Station Terminal

Improvements. An illustrated article explaining some of the difficulties in the construction of this new station in the heart of New York City. 1400 w. Sci Am—Sept. 16, 1905. No. 71902.

Rail Fastenings.

The Fastening of Rails to Cross-Ties by Means of the Collet Wooden Trenails (Sicherung und Befestigung der Schienen auf Holzschwellen durch Verdübelung nach System Albert Collet). George Schwabach. Well illustrated description and records of experience. Serial. 1st part. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 8, 1905. No. 72167 D.

Shops.

The New Shops of the Lehigh Valley Railroad at Sayre, Pa. Illustrated description. 1000 w. Ry & Loc Engng. Sept., 1905. No. 71692 C.

Steel Ties.

Railway Cross Ties of Cast Steel (Traverses de Chemin de Fer en Acier Moulé). Ph. Rousseau. Illustrated description of steel cross ties and rail fastenings invented by A. Gouchet, and used in France. 1500 w. Rev Tech—June 10, 1905. No. 72144 D.

Tracks.

Some Practical Points in the Double Tracking of Railways. Gives the opinions of the Pennsylvania, Union Pacific, and Baltimore & Ohio railways on the conditions which determine the capacity of single-track lines, with discussion of the work, and opinions of other railways on various phases. Also editorial on this subject. 6600 w. Eng News—Sept. 14, 1905. No. 72048.

Modern Track Construction. A. Morrison. From paper entitled "The Construction and Maintenance of a Railroad Capable of Taking Care of the Present Traffic and Rolling Equipment," read before the Roadmasters' and Maintenance of Way Assn. 1800 w. Ry & Engng Rev —Sept. 23, 1905. No. 72240.

Track Elevation.

Track Elevation on the Chicago and Northwestern Ry., Chicago. Illustrated description of important and difficult work under trying conditions. Retaining walls, overhead and subway bridges, street improvements, track elevation, signal plants, etc., are embraced in the work. 4300 w. Eng News—Sept. 7, 1905. No. 72042.

Train-Shed.

A Novel Train-Shed for the New Hoboken Terminal of the Lackawanna. Illustrated description of a departure in train-shed design, stating the advantages claimed. 700 w. R R Gaz—Vol. XXXIX. No. 9. No. 71852.

Water Softening.

See Mechanical Engineering, Steam.

Yards.

Passenger Coach Yards. From a pamphlet compiled by Prof. Oder and Dr. Blum on German and American practice. 2500 w. R R Gaz—Vol. XXXIX. No. 10. No. 71860.

New Freight Yard of the Burlington at Galesburg. Gives a map showing the situation at this important point, with plans and description of the yard arrangements. 1000 w. R R Gaz. Vol. XXXIX. No. 10. No. 71855.

TRAFFIC.

Freight.

Time Freight on the Chicago & Northwestern. Gives particulars of the system in use. Ills. 1000 w. R R Gaz—Vol. XXXIX., No. 9. No. 71854.

The Great Northern Line Freight System. Gives particulars of the system used. 900 w. R R Gaz—Vol. XXXIX. No. 10, No. 71856.

MISCELLANY.

Canadian Railroad.

A Government Railroad. Editorial on the present condition of the Intercolonial Railway of Canada, as stated by Mr. Emmerson, Minister of Railways and Canals. 2000 w. R R Gaz—Vol. XXXIX. No. 11. No. 71912.

C., H. & D. Sale.

The Cincinnati, Hamilton & Dayton Sale. Editorial on the sale of this road to the Erie, and the effects from the change of control. 1500 w. R R Gaz—Vol. XXXIX. No. 12. No. 72209.

Costs.

Units of Costs. A. H. Plant. Address at meeting of the Assn. of Am. Ry Accounting Officers, New York. 1700 w. Ry Age—Sept. 1, 1905. No. 71824.

Division Engineers.

The Division Engineer in Railway Work. Willard Beahan. A discussion of the qualifications desirable in a successful division engineer, and the character of his work, giving suggestions. 6800 w. Jour W Soc of Engrs—Aug., 1905. No. 71989 D.

English Railways.

Some English Railways. Editorial review of the returns of the first six months of the present year, with discussion of the traffic, service, etc. 2000 w. Engng—Aug. 25, 1905. No. 71775 A.

Government Control.

Government Control of British Railways. A brief study of the relations between the British Board of Trade and the railways of the United Kingdom.

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2800 w. Ry Age—Sept. 15, 1905. No. 71937.

Railroad Commissions.

Powers, Duties and Work of State Railroad Commissions. Report presented at meeting of the Nat. Assn. of R. R. Com., Deadwood, S. D. A discussion of this subject. 3500 w. Ry Age—Sept. 1, 1905. No. 71825.

Valuations.

Railroad Valuations in State Reports. Abstract of a report by Prof. Harold M. Bowman, made for Bul. No. 21, of the Census Bureau. Briefly explains the systems of valuation provided for by the laws of the several states, giving a critical review of the systems and administrative reports. 4500 w. R R Gaz—Vol. XXXIX. No. 10. No. 71857.

The Census Office Railroad Valuation. An editorial discussion of the work of Prof. Adams. and his assistants. 2500 w. R R Gaz—Vol. XXXIX. No. 9. No. 71850.

Railroad Taxes and Plans for Ascertaining Fair Valuation of Railroad Property. Report presented at the Nat. Assn. of R. R. Com., Deadwood, S. D. Considers the best means of taxing railroad properties, and the best means of determining the fair valuation of the properties. 2500 w. Ry Age—Sept. 8, 1905. No. 71827.

STREET AND ELECTRIC RAILWAYS

Belgium.

The Street Railway System of the Borinage. Dr. Alfred Gradenwitz. Illustrated description of this single-phase system in the Belgian Colliery district, and its equipment. 2000 w. Elec Rev, N Y—Sept. 23, 1905. No. 72213.

Brakes.

An Emergency Track Brake for Street Railways. F. F. Bodler. Illustrated description of the Slipper track brake used on street railway cars in San Francisco, Cal. 1000 w. Eng News—Sept. 28, 1905. No. 72282.

Brooklyn.

See Electrical Engineering, Generating Stations.

Brunnen-Morschach.

The Electric Rack Railway from Brunnen to Morschach (Die Elektrische Zahnradbahn Brunnen-Morschach). Well illustrated description of a three-phase rack railway near the Lake of Lucerne. Serial. 2 parts. 4000 w. Schweiz Bauzeitung—Sept. 2 and 9, 1905. No. 72119 each D.

Car Lighting.

Car Lighting. Robert N. Tweedy. Discusses the cost of the lavish illumination now demanded, the effect on the eyes, and gives points that should be taken into consideration when a car is being designed. 2000 w. Elec Rev, Lond—Aug. 25, 1905. No. 71763 A.

Cars.

New Standard Cars of the Chicago City Railway Company. Illustrated article describing the new features of these cars, with editorial comment. 6200 w. St Ry Jour—Sept. 16, 1905. No. 72089 C.

Car Shops.

See Civil Engineering, Mechanical Engineering.

English Construction.

English Street Railway Construction. Joseph Owen. Abstract of a paper read before the Incor. Assn. of Munic. and County Engrs. describing the rails and fish-plates, joints, and special work, tie-bars, bonds, etc. 3200 w. Eng News—Sept. 7, 1905. No. 72045.

Erith.

Erith Electric Tramways. Illustrated detailed description of this recently completed link in Greater London's system. 2500 w. Tram & Ry Wld—Sept. 14, 1905. No. 72086 B.

The Erith Electric Tramways. General description of tramway system of town on lower Thames, 13 miles from London. 2000 w. Elect'n, Lond—Sept. 1, 1905. No. 71746 A.

The Erith Electric Tramways. Illustrated description of the sections of the tramways of the Erith Urban District Council recently opened. 2500 w. Elec Engr, Lond—Aug. 25, 1905. No. 71754 A.

Freight Service.

I. The Electric Freight Railway Service. H. H. Polk. II. Some Consideration of Operation Involved in Changing from Steam to Electric Power on Railroads. D. McNichol. Two papers discussed together. 7500 w. Pro Iowa Ry Club—June 12, 1905. No. 72249 C.

Ground Return.

The Treatment of the Ground Return in Railroad Systems. Albert B. Herrick. Discusses how to improve this portion of the system with the least possible cost. The question of bonding and considerations bearing upon it. 2200 w. St Ry Rev—Sept. 15, 1905. No. 72222 C.

Jungfrau.

The Jungfrau Railroad. Reginald Gor-

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don. Explains the difficult construction of this line, the progress made, and the portion now open to the public. 1200 w. R R Gaz—Vol. XXXIX. No. 11. No. 71918.

London Traffic.

The Extension of Traffic Facilities in London. Describes the situation, and discusses possible improvements; also considers the electrification of the underground roads, and the new lines in process of construction. 4800 w. Bul Int Ry Cong—Vol. XIX. No. 6. No. 71994 G.

Manila.

American Trolleys in Manila. Short general description with illustration. 700 w. Elec Wld & Engr—Sept. 2, 1905. No. 71713.

N. Y. Elevated Wreck.

The Elevated Railroad Wreck in New York. Brief illustrated description of the recent fatal accident at the 53rd street curve. 700 w. Sci Am—Sept. 23, 1905. No. 72203.

New York Subway.

New Paint Conditions Existing in the New York Subway. Maximilian Toch, in the *Jour. of the Soc. of Chem. Ind.* A report of investigations made of the conditions showing that a pigment compound with linseed oil is not fit for subway work. 1200 w. Eng Rec—Sept. 23, 1905. No. 72226.

New Zealand.

Christchurch Electric Tramways. James Drummond. Illustrated description of first municipal installation of electric traction in New Zealand, opened June 5, 1905. 4000 w. Tram & Ry Wld—Sept. 14, 1905. No. 72087 B.

Philadelphia.

Analysis of Transportation Conditions in Philadelphia. Discusses the traffic districts, conditions which effect transportation, the congestion problem, trends of travel, etc., giving many illustrations. 3500 w. St Ry Jour—Sept. 23, 1905. No. 72227 C.

The Philadelphia Subway and Elevated Railroad. Illustrated description of the new Market street trunk line of the Rapid Transit Co., the engineering features of the subway and elevated divisions, and the new bridge over the Schuylkill River. 6800 w. St Ry Rev—Sept. 15, 1905. No. 72218 C.

The Subway and Elevated Lines in Philadelphia. Describes the general conditions of the West Market street subway, the ventilation, Schuylkill River bridge, elevated structure, shops, etc. Illus. 5300 w. St Ry Jour—Sept. 23, 1905. No. 72234 C.

Department of Lines and Cables. Considers the direct current, and alternate current cables, underground conduits, overhead construction, telephone system, etc. of the Philadelphia system. Ills. 3000 w. St Ry Jour—Sept. 23, 1905. No. 72231 C.

Operating Methods in Philadelphia. An account of the organization, personnel, employment department, way bills, crossings, etc. 4500 w. St Ry Jour—Sept. 23, 1905. No. 72229 C.

Car Houses, Repair Shops and Rolling Stock. Illustrated descriptions. 1400 w. St Ry Jour—Sept. 23, 1905. No. 72233 C.

Distribution System of the Philadelphia Rapid Transit Co. Illustrated description of the methods of distribution both in the underground feeder system, high-potential lines, telephone lines, etc. 2000 w. St Ry Rev—Sept. 15, 1905. No. 72220 C.

Generation and Distribution of Power in the Philadelphia Rapid Transit System. Describes the general power scheme, the direct-current stations, alternating-current stations, new turbine station, etc. Ills. 9000 w. St Ry Jour—Sept. 23, 1905. No. 72232 C.

History, Organization and Financial Characteristics of the Philadelphia Rapid Transit Company. Reviews the early lines, race question, introduction of mechanical traction, operating factors, etc. Ills. 6500 w. St Ry Jour—Sept. 23, 1905. No. 72228 C.

Way and Roadway Matters in Philadelphia. Describes types of track construction, special work, shops, appliances, etc. Ills. 8500 w. St Ry Jour—Sept. 23, 1905. No. 72230 C.

See also Electrical Engineering, Generating Stations.

Philippines.

Public Engineering Work in the Philippines. Information from the report of the Philippine Commission concerning the public works in the provinces. Ills. 4000 w. Eng Rec—Sept. 23, 1905. No. 72225.

Physical Analysis.

The Physical Analysis of an Electric Railway Property. Albert B. Herrick. Discusses the character of a physical report, explaining some of the graphical methods used to represent the conditions. 3000 w. St Ry Jour—Sept. 23, 1905. No. 72236 C.

Power Stations.

The Power Station. Fred N. Bushnell. Read before the Am. Ry., Mech. & Elec. Assn. Describes the type of station most generally adopted for street railway work, the apparatus employed, and matters of interest, in regard to the service. Ills.

We supply copies of these articles. See page 319.

8000 w. St Ry Jour—Sept. 30, 1905. No. 72353 C.

The Power Station Load Factor as a Factor in the Cost of Operation. Lawrence P. Crecelius. Read at the convention of the Am. Ry., Mech., & Elec. Assn. Outlines a method employed by the United Ry. Cos. of St. Louis, in increasing the load factors of the main power stations, showing how the load factor plays a part in the cost of power per car-mile. 1800 w. St Ry Jour—Sept. 30, 1905. No. 72349 C.

Rail Joints.

New Rail Joints for Street Railways and their Installation on the Berlin Street Railway System (Neue Schienenstossverbindungen für Strassenbahnen und deren Einbau bei der Grossen Berliner Strassenbahn). Article from the *Elektrotechnische Anzeiger*, giving illustrated description of the Melaun and other rail joints. 2000 w. Mitt d Ver f d Förderung d Lokal u Strassenbahnwesens—Aug., 1905. No. 72148 D.

St. Gall.

The Electric Railway from St. Gall to Speicher and Trogen, Switzerland (Chemin de Fer Electrique de Saint-Gall à Speicher et à Trogen, Suisse). H. Somach. Illustrated description of direct-current railway, about 6 miles long, rising 900 feet. 2000 w. Génie Civ—Aug. 26, 1905. No. 72135 D.

Shops.

See Civil Engineering, Construction.

Signal System.

The Block System of the New York Subway (Das Blocksystem der New Yorker Untergrundbahn). S. G. Freund. Well illustrated description of signal system and safety appliances. 4000 w. Elektrotech Zeitschr—Sept. 14, 1905. No. 72158 B.

Single-Phase.

Single-Phase Alternating-Current Car Control. R. P. Jackson. Illustrated detailed description of a system of control adapted for the operation of cars or locomotives of any size. 1600 w. Elec Jour—Sept., 1905. No. 72030.

See also Electrical Engineering, Motors.

The Single-Phase Railway in Practical Operation. Gives an account of the operating experience of three equipments of this kind which have been in regular service some months. Ills. 4000 w. Elec Wld & Engr—Sept. 23, 1905. No. 72215.

Sprinkler.

Motor Sprinkler at Cologne. Illustrated description of a new type of motor sprinkling car in use in connection with the traction lines. 1200 w. Sci Am—Sept. 2, 1905. No. 71833.

Switzerland.

The Montreux-Oberland-Bernois Railroad. Frank C. Perkins. Illustrated detailed description of an interesting electric line traversing one of the most beautiful parts of Switzerland. 1200 w. R R Gaz—Vol. XXXIX. No. 10. No. 71858.

Third-Rail.

Under-Running Third-Rail for the New York Central. Illustrated detailed description of the type of third-rail under trial with a view to using it in the zone around New York. 1300 w. R R Gaz—Vol. XXXIX. No. 9, No. 71851.

New York Central Third Rail. Brief description with illustrations, of the under-contact type adopted. 700 w. Elec Wld & Engr—Sept. 2, 1905. No. 71712.

Under-Contact Third Rail for the New York Central. Illustrated description of current-carrying rail to be used in New York and vicinity. 600 w. St Ry Jour—Sept. 2, 1905. No. 71730 C.

New York Central Under-Contact Third Rail. Brief illustrated description of the plan adopted, which has the rail protected by a sheathing which leaves only the under surface exposed. 700 w. Ry Age—Sept. 1, 1905. No. 71826.

Toledo & Western.

Freight Development on the Toledo & Western Railway. Illustrated account of the growing freight business of an interurban electric railway in Ohio and Michigan. 3000 w. St Ry Jour—Sept. 2, 1905. No. 71728 C.

Track Changing.

Changing the Gauge of Tracks in East St. Louis. W. A. Bennett. Methods employed in changing electric street railway tracks from broad to standard gauge, with detailed cost of work. 1800 w. St Ry Jour—Sept. 9, 1905. No. 71733 C.

Tramways vs. Omnibuses.

Electric Tramways v. Motor Omnibuses. Gives reports of Mr. Stephen Sellon and Mr. W. Worby Beaumont, with other information which led to the decision to establish electric traction in Oxford. Also editorial. 6500 w. Elec Engr. Lond—Sept. 8, 1905. No. 71761 A.

Zossen.

The Berlin-Zossen High-Speed Tests of 1901. An extensive résumé of these electric railway experiments, particularly on train resistance and braking, with curves and tables. 8000 w. St Ry Jour—Sept. 9, 1905. No. 71732 C.

We supply copies of these articles. See page 319.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

South Africa.

The Geology of South Africa. By F. H. Hatch and G. S. Corstophine. Size, 9 in. by 6 in. pp. vii, 339. Price, 21 shillings. London: Macmillan and Co., Limited. New York: The Macmillan Company.

This is a work including the results of both the official results of government geological surveys and the researches of private investigators, the whole constituting an excellent description of the geology of a portion of the world now attracting much attention. The book is of especial value as forming a systematic arrangement of the results of the investigations of the non-official worker in South African geology, arranging in coherent form matter which would otherwise be inaccessible and scattered through the pages of scientific journals of many lands in many languages. Both of the authors of this work have been engaged in geological work in South Africa for many years, both at the Cape and in the Transvaal, where they have had many opportunities of discussing the numerous problems which have been forced upon them. This has enabled the authors to appreciate very fully the valuable work of other geologists in the South African field, and given them opportunity of removing some of the difficulties which lie in the way of the full realisation of the interesting nature of South African geology. The work is admirably illustrated with photographs, sections, and maps, the latter including a geological map of South Africa, on a scale of 1 : 5,000,000 and a geological map of the Transvaal on a scale of 1 : 1,250,000.

Lathe Work.

Engineers' Turning. A Handbook for Working Engineers, Technical Students, and Amateurs. By Joseph Horner. Size, 8½ by 5½; pp. xii, 404. Price, 9 shillings. London: Crosby Lockwood and Son.

There have been numerous books written upon the subject of the lathe itself, but comparatively few of these have discussed the actual use of the machine, the subject of turning, as considered apart from the machine upon which the work is done. It is this phase of shop work which Mr. Horner discusses, and he has succeeded in producing a valuable and interesting volume. The lathe itself is given a general examination, and the author then passes to the consideration of the tools with which the work is performed, the sources of error, and the general methods of testing for accuracy. Methods of supporting the work are then considered, followed by a discussion of drilling, boring, and allied operations. The important subjects of screw-cutting and turret-work are given separate chapters, while special work, such as grinding, fitting, and other departments of lathe work are successively considered. The use of high-speed steels is considered, and the conditions under which it can be used to advantage, the work closing with instructions from the various makers of modern tool steels as to the best methods of handling their products.

Mr. Horner has succeeded in producing a valuable and interesting book upon one of the most important departments of machine-shop work and one of a kind of which there are unfortunately too few available.

BOOKS RECEIVED.

Etude Théorique et Pratique de l'Incendie. Par Félicien Michotte. Price, 15 francs. Paris: Vve. Ch. Dunod.

Engineering Chemistry. By Thomas B. Stillman. Price, $4.50. Easton: The Chemical Publishing Co.

Modern Refrigerating Machinery. Translated from the German of Prof. Hans Lorenz by Thomas H. Pope; with additional chapters by H. M. Haven and F. W. Dean. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Graphic Methods of Machine Design. By Arthur H. Barker. Price, 3 shillings 6d. Manchester: The Technical Publishing Company, Ltd.

The Mechanical Equipment of Collieries. By C. M. Percy, completed and edited by Frank Percy and George H. Winstanley. Price, 21 shillings. Manchester: James Collins & Kingston, Ltd.

Machine Shop Tools and Methods. By W. S. Leonard. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.